ENGINEERING AND MINING JOURNAL

In this issue

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Various Geological Problems and How They Are Interpreted

Electrostatic Separation Advances in Phosphate Recovery

Gold Dredging in Southwestern Oregon

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WEAR TESTS—RUBBER

Sample Identification Number	WEIGHT BEFORE TEST	WEIGHT AFTER TEST	WEIGHT LOSS OR WEAR
1	62.8 Gr.	62.0 Gr.	.8 Gr.
2 (Maximix)	56.2	55.7	.5
3	52.2	50.3	1.9
4	50.0	47.6	2.4
5	33.4	32.7	.7
6	57.8	56.6	1.2
7	61.9	61.3	.6
8	60.5	59.75	.75
9	Broke down in 3 to 4 minutes		

LABORATORY TESTING — MAXIMIX RUBBER — ABRASION RESISTANCE

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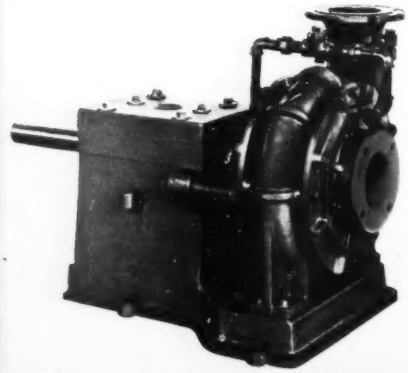

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Electrostatic separation is now being used by one operator in the pebble phosphate field of Florida for further cleaning or refining the concentrates made by flotation. This innovation accomplishes three things: produces the highest possible grade of washed phosphate rock for the market; increases the total recovery; and tends to lengthen the life of the country's phosphate resources. The how and why of the new development are told by Herbert Banks Johnson in this issue, on page 35.

▼

April *E.&M.J.* will be devoted almost entirely to the timely story of the development and operations of the newest entrant into the ranks of producers of potash in the United States—the Union Potash and Chemical Co. Taking time by the forelock and anticipating the country's needs, this subsidiary of International Agricultural Corporation spent about $3,000,000 last year in opening the mine from shaft bottom, equipping with modern machinery, and rushing into its first production within a scant ten months' time. This outstanding mining development of 1940 warranted full coverage for *E.&M.J.* readers, and A. H. Hubbell, associate editor, has recently returned from Carlsbad, in New Mexico, where the property is situated, with a detailed description and numerous illustrations of the new enterprise. It has many points of interest.

▼

South American mining activities are of increasing interest, and more articles from our neighbors are being developed for future publication in *E.&M.J.* In this number, p. 54, operation of the International Mining Corp., tin dredge near Huanuni, Bolivia, is described. The importance of tin as a war metal and the fact that this is the only dredge which has worked in Bolivia for many years adds timeliness to this interesting article.

H. C. PARMELEE
Editor

ENGINEERING AND MINING JOURNAL

H. W. CLARKE
Vice-President

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COVER ILLUSTRATION: The pattern made of cupels at the assay office of Combined Metals Reduction Co., Stockton, Utah, indicates finals on some of the ore samples

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Volume 142 MARCH, 1941 Number 3

Speeding Metal Production

PLANS FOR NATIONAL DEFENSE have moved into high gear so far as the mineral industry is concerned, and with that action has come a keener realization by American business and industry that the United States is operating in a war economy. In fact, the realization may have come as somewhat of a shock, because, as defense officials have repeatedly pointed out, the country has been slow to take defense seriously. But with the recent emphasis on speed, supplemented by a few priorities, embargoes, and other departures from normal business routine, it is expected that the nation will soon understand that "guns *and* butter" are out of the question. We may have one or the other, but not both. Currently the emphasis is on guns, and will be until the emergency is over.

This means that metals will be diverted from customary channels of use; that ordinary industrial processes will be upset; that substitute materials will have to be sought and used; and that some lines of manufacture may have to be discontinued temporarily. But it does not mean that consumers need grow hysterical over apparent shortages of metal, or aggravate abnormal conditions by hoarding inventories or buying on speculation. Admittedly there is maldistribution of metals that are important to defense, but conditions can be vastly improved by prudence and restraint on the part of buyers. Without such voluntary cooperation they can look for the less palatable, but effective, mandatory priority. Although it would not be fair or accurate to decry the tight situation in some metals, or to say that there is plenty of metal for all uses, nevertheless conditions probably are not as black as they are painted. What is needed most is patience and understanding.

Aluminum is under mandatory priority for reasons hinted at above and more definitely stated in our Washington news; but producers are working at top speed to remedy a shortage that could not have been foreseen. Compared with domestic production of 412,560,000 pounds in 1940, the United States will be producing aluminum at the rate of 690,000,000 pounds by the middle of this year, and 825,000,000 pounds by mid-1942. Little more in the way of expansion could be asked of any industry. Meantime it becomes necessary to allocate all aluminum to defense orders.

Zinc affords another outstanding example of tremendous activity to meet unexpected defense demand. Normally producing about 500,000 tons annually, the industry in the United States will be producing metal at the rate of 900,000 tons a year before the year is out.

Nickel, although not produced in this country, is flowing in a steady stream from Canada, probably at a rate exceeding fabricating capacity in the United States. Here is an obvious example of maldistribution probably resulting from a scramble by consumers to "protect" their requirements. Copper is believed to be well in hand, with domestic production at more than one million tons a year—the highest on record—and Latin American metal scheduled for delivery here this month.

The present situation, with its apparent shortages, is unavoidable, but its difficulties can be ameliorated by the exercise of a little patience and common sense. After all, smart as we are, we cannot hope to accomplish in a few months what Hitler and Mussolini have been working toward for years. Time is the great bottleneck.

Priorities in the Offing

WHETHER you are a mining machinery manufacturer or a mine operator, you will be wise to investigate now the possible effect of defense priorities on your supply of raw materials and equipment. We are not advocating immoderate buying or hoarding, but merely sounding a note of caution and prudence in the face of emergency conditions. Our Washington office informs us that the Office of Production Management has established a general pattern for priorities, allocations, and voluntary rationing, and that the priorities division of OPM is prepared to act promptly to meet any situation that may arise. So mandatory priorities are on the way; have already been applied to aluminum and machine tools; and will be extended to other commodities as needed.

Considering the vital relation of mining to the defense program, it is inconceivable that OPM will allow anything to interfere with con-

tinuous metal production at the highest rate. But it is quite possible that in the general scramble for raw materials and supplies, temporary shortages may be encountered. In such circumstances it may be necessary for manufacturer or operator, or both, to appeal to Washington for relief. In order to facilitate the correct approach we publish in the Washington news on page 76 an organization diagram of those divisions of OPM of direct interest to metal mining. We believe this information will be adequate for initial inquiries, but shall be glad to supplement it with further service on request from manufacturers or operators.

Tin Smelter Located

IN THE SPOTLIGHT OF THE NEWS in late February, as reported on page 86 of this issue, was the long-awaited decision of the Government on the location of the tin smelter and the identity of the builder and operator. In recent months no other topic has aroused so much speculation in mining and metallurgical circles, so the decision brought welcome relief from suspense. Rumor had already placed the plant successively at several points on the Gulf and Atlantic coasts, and gossip had mentioned each of several prominent metallurgical concerns as operator. But, as frequently happens in such cases, the location and operator finally selected were not even prominently mentioned in rumors or speculation discussions.

Selection of a site on the Gulf coast apparently was based on shipping facilities and defense against enemy attack, and was concurred in by Army and Navy officials and the National Resources Planning Board. Choice of a Dutch, rather than an American, concern to build and operate the plant was dictated by the former's successful experience in smelting Bolivian concentrates, which admittedly offer a refractory metallurgical problem.

Unhappily, tragedy followed close on the selection of the Dutch experts when Mr. B. C. M. van der Hoop was killed in a plane crash on his way from New York to Galveston.

Two-Price Policy for Metals?

REQUEST by defense authorities for an investigation into the cost of producing copper, revives speculation on the possibility of adopting a two-price policy for newly mined metals for defense. The thought grows out of the contention of miners in high-cost areas that, instead of buying copper from Latin America, the Government should encourage marginal domestic production by allowing the price to rise above the present 12-cent level. The obvious rejoinder of defense authorities to that proposal is that present profitable producers should not enjoy a higher price than they now receive. So a compromise suggests itself in the form of a bonus to operators that cannot produce metals profitably at present prices.

Well, if the Metals Reserve Company can buy 235,000 tons of copper from Latin America at 10 cents a pound, it might conceivably raise the ante for some marginal domestic producers to, say, 15 cents. It would first be necessary to separate the 12-cent goats from the 15-cent sheep, but that procedure would be no more arbitrary than the whole price policy now imposed on the industry. The cost of the bonus would be offset in part, at least, by the advantage gained in Latin American purchases, and the benefits of employment would be conferred on communities whose welfare is wholly or largely dependent on mining activity. The plan might be tried for a predetermined period of time or for a specified tonnage of metal.

Plastics vs. Metals

IT WAS INEVITABLE that the versatile plastic should be recommended to manufacturers as a substitute for metals once plentiful but now diverted to purposes of national defense. It was equally evident, however, that an attempt to adopt all of the recommended substitutions would soon result in a shortage of plastics—eloquent testimony to the fact that industry cannot respond one hundred percent to the defense program without disrupting normal productive enterprise. But more important than the extent to which plastics may now be substituted for metals is the threat that substitution may be permanent after the emergency is over. Markets once abandoned to a competitive commodity may never be recovered. Uses developed at considerable cost may be lost forever to a substitute that does an emergency job. With respect to some of their present uses, metals may be like volunteers who patriotically go to war and return home to find all the good jobs taken by those who stayed behind.

The answer to the problem is twofold. First, product research to develop new uses for metals. This is a vital activity that can and should be continued in spite of defense and war programs. Second, aggressive merchandising, even in the face of complete diversion of metals to defense purposes. The industry cannot afford to let the world forget either its products or their manifold uses.

Electrostatic Separation Scores Advance in Phosphate Recovery

In combination with flotation it increases the total recovery and yields a shipping product of higher grade

Herbert Banks Johnson
Vice President
Ritter Products Corporation,
Rochester, N. Y.

A SERIES of articles now appearing in *Engineering and Mining Journal*, by A. H. Hubbell, Associate Editor, clearly describes mining, washing, and flotation operations as now practiced in the phosphate industry, both in Florida and Tennessee.

The following paragraphs deal particularly with the recent addition of the Johnson process for the refining of phosphate concentrates now being produced by the flotation process in the Florida pebble field. They have to do with a new method of electrostatic separation (*E.&M.J.*, Dec., 1938, p. 41), which within the last two years has been commercially applied and is producing not only the highest possible grade of B.P.L. (bone phosphate of lime) concentrates but, in combination with the flotation process, is making the highest total recovery of phosphate from the matrix, thereby considerably extending the life of our national resources. For many years, I have been advocating the use of these two basic principles of concentration for many ore-dressing problems, to obtain the greatest simplicity of operation and the best concentrating efficiency as well as the highest recovery of values.

Phosphate can be generally classified as a low-priced material, bringing approximately $2.75 to $3.50 per long ton at the source of supply. The price varies with the B.P.L. content. Freight rates to market destinations are about equal to, and in some cases are greater than, the selling price of the phosphate at the mines. The insoluble content, composed principally of silica, has no value. Therefore, phosphate with minimum insoluble content sells at a premium, usually based on the B.P.L. content.

In the recovery of phosphate from the matrix, the washers play a very important part. In the early days, pebble phosphate, plus 10 mesh in size, was the only product sold. Consumers became accustomed to handling this size of material and, even at present, many of them insist on using it. The rest of the phosphate in the matrix, which would pass a 20-mesh screen, was wasted as washer tailings.

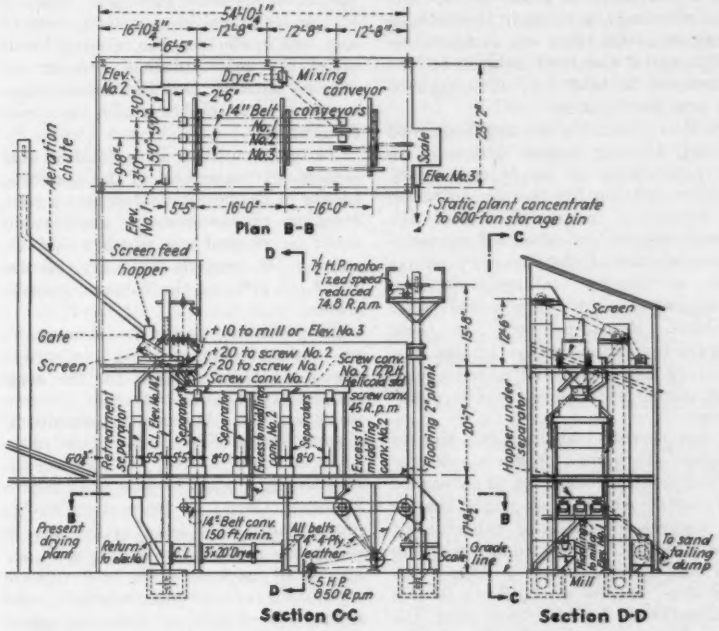


Fig. 1 . . . General plant layout, Johnson process of electrostatic separation of phosphate rock

With the application of flotation, it became necessary to improve washing operations to recover from the washer tailings a portion of the phosphate ranging in size between 20 and 150 mesh. The slimes consumed an excessive amount of flotation reagents, increasing the cost beyond practical requirements, with no appreciable additional recovery of phosphate. It is necessary, therefore, to remove the maximum amount of slimes from washer tailings or head feed to the flotation plant to assure best and most economical flotation performance.

Recovery of phosphate in flotation operation is of vital importance. Every ton lost in the tailings bears the same expense as each ton of phosphate recovered in the concentrates. I believe that concentrate grades above 75 percent B.P.L. are secured at the expense of recovery and, due to the shipping requirements, the flotation plants in the phosphate field have, in the past, been operated primarily for grade of concentrates rather than for recovery of phosphate. Within the last five years, more attention has been given to increased recovery. For example, wet tables have been successfully applied and are particularly successful in obtaining a high recovery from the coarser sizes. In some of the flotation plants two sizes are being separated. This procedure offers a higher recovery, particularly on the finer sizes.

Failure of early attempts at electrostatic separation—On several occasions during the past twenty years I have attempted to separate phosphate elec-

trostatically, with very little success, using the old Huff process and separating equipment that was so successfully applied to lead, zinc, and other ores. During that time I found it impossible to secure a combination of high recovery and marketable grade. Tests made for several of the companies in the Florida district showed no possibilities of commercial application.

In 1937 I made a discovery in the art of electrostatic separation which I knew, from long experience, would greatly broaden the possibilities of commercial application. Considerable research work in equipment design, and development of a new list of minerals with regard to their electrostatic behavior, necessitated the complete redesigning of electrical equipment and separators to take full advantage of the new development.

In view of much wider application of the art, I again became interested in the possibilities of applying electrostatic separation for the concentration of phosphate rock. I visited the Florida district and obtained representative samples of the various products such as washer tailings, flotation concentrates, and Fahrenwald sizer products. Research work on these samples involving the use of the new discovery and greatly improved equipment, developed some surprising possibilities.

I was skeptical about being able to separate flotation products electrostatically, on account of the reagent film coating which I felt might change the natural electrostatic behavior of these minerals. In accordance with my previous investigations, I found this to be true, but, by working out several combinations, I discovered that the reagent coating on these particles could be used advantageously and that, with a proper combination of separating equipment, a very clean silica product could be separated from the flotation concentrates, proving to my own satisfaction that a combination of flotation and the new electrostatic development would offer a much better separation control than either process used by itself.

Successful application to flotation concentrates—My investigations indicated that flotation recovery in the Florida district could easily be increased from 80 percent to 90 percent. The flotation process, therefore, could be operated for recovery instead of grade, leaving the grade control to electrostatic separation. This new combination would show a profitable operation provided there was little loss in the electrostatic treatment, because any loss in electrostatic refining would offset the gain obtained through increased recovery and additional premium prices for higher-grade phosphate concentrates.

Tests on representative flotation concentrates from several of the operating plants in Florida indicated that a combination of electrostatic applications could be worked out which would assure a 99 percent recovery of the B.P.L. in refining the flotation concentrates.

The next step was to find a company in the Florida district interested enough to build a plant for the commercial application of the Johnson process. The American Agricultural Chemical Co., New York, with phosphate mines at Pierce, Fla., became interested in a plan to join with Ritter Products Corp., of Rochester, N. Y., in combining its long experience in phosphate mining and milling with our 30 years' experience in electrostatic separation of various minerals, and agreed to install a full-size plant adjacent to its drying operations at Pierce, in order to develop the new process from the laboratory stage to commercial operation and prove its practicability. Full credit for this development work, extending over a period of two years, and the commercial application of this new advancement in phosphate recovery, is due largely to the interest and foresight of the production and engineering departments of the first-named company, in full co-operation with myself and Ritter Products Corp. engineers.

Advantages of combination process—In our consideration of the problem we had several advantages on the credit side:

1. A flotation plant could be operated for maximum recovery and the increase in tonnage of phosphate from the matrix would, to a considerable extent, offset the cost of electrostatically refining and controlling the grade.

2. The electrostatic separation of Fahrenwald sizer products, increasing the grade from approximately 60 to 65 percent to 70 to 73 percent B.P.L. content, would permit a direct mixture of static concentrates produced from Fahrenwald products, with the higher B.P.L. grade static concentrates produced in refining flotation concentrates, thereby increasing the tonnage of shipping phosphate per ton of matrix mined.

3. By being able to use, as a head feed to the static plant, flotation concentrates of 71 to 75 percent B.P.L. content, and producing continuously an electrostatic concentrate of plus 77 percent B.P.L. content, the storage problem involved in the handling of flotation concentrates, due to the variation in the grade, could be much simplified. Instead of maintaining storage piles of different grades of flotation concentrates ahead of the drying plant to meet incoming B.P.L. requirements on shipping orders, concentrates could be used continuously direct from the flotation plant or could be taken off a general storage pile.

4. Since flotation and Fahrenwald concentrates must be dried before ship-

Fig. 2 . . . Screw conveyors feeding electrostatic separators, Section C-C, Fig. 1

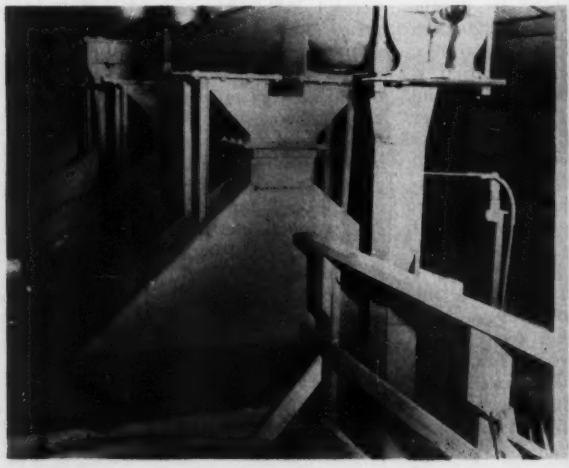


Fig. 3 . . . Electrostatic separators below screw conveyors. C-C, Fig. 1

ment, the drying cost is not chargeable to the static refining cost. Therefore, we believe that if the grade could be increased better than 3 percent B.P.L. content and a recovery of approximately 99 percent obtained in electrostatic refining, the operation would be profitable not only from the increased revenue in premium payments but in greater flexibility and increased operating efficiency as well as phosphate recovery.

We estimated the minimum profitable refining plant production to be 25 long tons of static concentrates hourly, or 600 tons daily. Therefore, our plant was designed to handle from 28 to 30 long tons of flotation concentrates hourly.

This refining plant was put into operation in September, 1938. We, naturally, had several months of experimental work coordinating the drying and static operations. We used for this work two old cylindrical, direct-heat dryers, 4 ft. in diameter by 28 ft. long, which have been in use for approximately 28 years. After making some modifications and improvements, we were able to maintain an hourly capacity of 28 to 30 tons of flotation concentrates, which are much more difficult to dry than regular pebble phosphate. We reduced the moisture content from an average of about 10 percent to approximately 1 percent, including concentrates shipped direct from the flotation plant and feed taken off storage piles, giving us a dryer head feed varying from about 7 to 13 percent moisture.

In the improvement of these two dryers we effected some economies in oil consumption. We would not encounter the drying difficulties which we experienced in this case if we were installing a new plant adjacent to new modern dryers. We are, however, gratified to know that we could use two old dryers and adapt them for drying minus 20-plus 200-mesh flotation concentrates at such high tonnage capacities and suitable for satisfactory electrostatic separation. This plant has now been in continuous operation for 18 months.

Flexible flowsheet aids experimentation—In the design of this refining plant, we provided the necessary equipment which enables us to operate on at least four different flowsheet combinations for the treatment of flotation concentrates as well as various products from the Fahrenwald sizing operation, and it is so arranged that we can quite easily change from one flowsheet to another. Our objective is thoroughly to explore the possibilities of new electrostatic separation. The flowsheet shown, however, indicates procedure used for the handling of flotation concentrates which are being refined at an average hourly capacity of 24 to 25 long tons.

Flotation concentrates discharged from the dryers are elevated and passed over a scalping screen where the plus-10-mesh phosphate, trash, etc., are removed prior to electrostatic separation. From this scalping screen the material is conveyed to four Johnson process electrostatic separators, each having a capacity of approximately 10 tons per hour. These four separators are used for the primary separation, producing a final concentrate which goes direct to a 600-ton static concentrate storage bin.

In this primary separation about 12 to 15 percent of middlings are produced, which are returned to the head feed, and a rough tailing composed primarily of silica and phosphate particles which have had the flotation reagents burned off in drying operations. This rough tailing, varying from approximately 5 to 10 percent weight, passes to another Johnson process electrostatic separator for secondary treatment. This separator produces a final tailing and a second concentrate or middling. The final tailing varies from 6 to 12 percent B.P.L. content.

The Johnson separators are designed so that an even feed at all times passes between the separating electrodes. These feed rolls are 8 ft. in length, each linear foot having the same capacity, which is controlled by feed gate adjustment. The number of electrodes used controls the grade of concentrates. Any variation in feed has practically no effect on the grade of separation.

Operating results—Practically no adjustments have been made on this separating equipment since first installed, and the only work which an operator is required to do is to maintain a constant potential at the switchboard, see that the machines are reasonably clean and the feed is flowing evenly. Any laborer can very quickly be broken in as an operator. One operator and a laborer are required for each shift.

In the treatment of flotation concentrates, the following performance is representative:

B.P.L. increase (flotation concentrates), from 2½ to 5 percent.

Insoluble content (static concentrates), from 3 to 3½ percent.

B.P.L. grade (static concentrates), from 77 to 80 percent.

Total recovery of B.P.L. in electrostatically refining flotation concentrates, 99 percent.

Power consumption for the entire plant, 3 kw.-hr. per ton of feed.

In the treatment of Fahrenwald products, with a head feed ranging from 60 to 65 percent B.P.L., the following percentage results are representative of plant operation:

Head Feed		*Concentrates*	
B.P.L.	*Insol.*	*B.P.L.*	*Insol.*
63.02	17.64	72.65	4.55
60.52	20.11	72.33	4.34
62.00	18.31	72.31	4.43

The actual separating cost, including labor, materials, supplies, maintenance, insurance, and plant write-off, is approximately 15c. per long ton of feed.

We have found that is is not economical to separate electrostatically any phosphate below 50 percent B.P.L. content, due to the drying cost of the silica, which at present has no commercial value.

Working conditions in this new refining plant are comparable with those of any well-controlled dry-process operation. The head feed to the static refining plant is dedusted and the fine dust removed and collected. This dust product may be used in acid plants direct, or, if necessary, it may be combined with the electrostatic concentrates for shipment, reducing the B.P.L. content slightly.

This new method of operation and better shipping-grade control involves

Fig. 4 . . . Discharge of concentrate on to belt conveyor below separators. Section C-C, Fig. 1

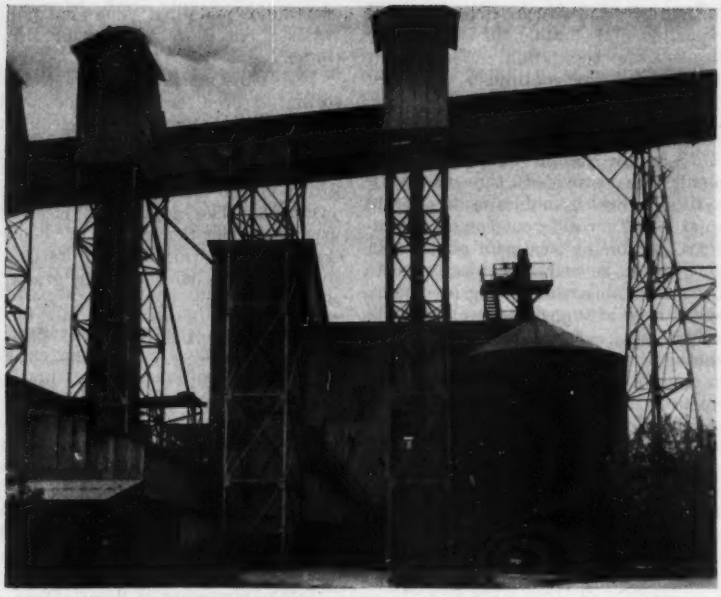


Fig. 5 . . . General view of the electrostatic separation plant of the American Agricultural Chemical Company at Pierce, Fla.

minimum changes in operating procedure and is particularly attractive when working deposits having a comparatively small percentage of phosphate which can be concentrated to only 74 to 75 percent grade by the flotation or tabling methods alone. It offers better possibilities of making consistently higher-grade shipping products for guaranteed selling contracts demanding the highest market price.

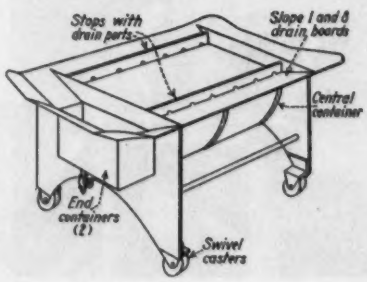
The combination of flotation and electrostatic separation will undoubtedly be used more extensively in the future for many ore-dressing problems. From our practical experience with this new Johnson process installation, we see no reason why tonnage from 25 to 200 tons per hour cannot be handled very economically. It is operating satisfactorily, making several other separations, both here and in foreign countries, operating under United States and foreign patents.

The Ritter Products Corp. maintains a modern research laboratory in Rochester, N. Y., where tests proving the possibilities of the process can be made promptly. Recently arrangements have been made with the American Agricultural Chemical Co. permitting the use of its plant in Pierce, Fla., for commercial demonstrations of the Johnson process, including separation of carload lots, at minimum expense. This is sometimes of considerable importance in getting complete information and data before proceeding with the commercial installation.

▼ ▼ ▼

Washing Tray for Machine Parts

THE accompanying sketch illustrates in detail a portable washing tray that saves time and patience in machine shops where mine, mill, and smelter equipment is repaired. It has been found useful in repair work on pumps, drills, and other machinery. As will be seen, the unit essentially consists of three compartments holding gasoline or some other grease-dissolving washing fluid, with sloping drain boards around the top on which the machine parts can be laid while being brushed off or where they can be left to drain. The center and largest compartment consists of the longitudinal half of a 32-gal. oil drum. At either end are the smaller compartments, each about 6x8 in. in section and 24 in. long. All three containers have separate drains controlled by globe valves, with ¾-in. pipes draining the end compartments and a 1½-in. pipe leading out of the center section.

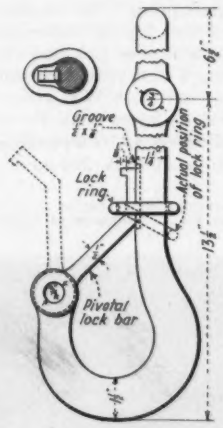


The supporting frame is made up of two vertical steel plates ½ in. thick, welded to the ends of the oil drum and carrying rubber-tired swivel casters at the lower corners. The drain boards, with a slope of 1 and 8 on the sides, have stops or steel partitions that prevent machine parts laid thereon from sliding into the center container. Liquid drains back into the tank through ports or openings provided at the bottom of each stop. The device was developed by the mechanical department of Griffith Bros. and Bent Bros., contractors, and is used at Friant dam, now under construction in central California.

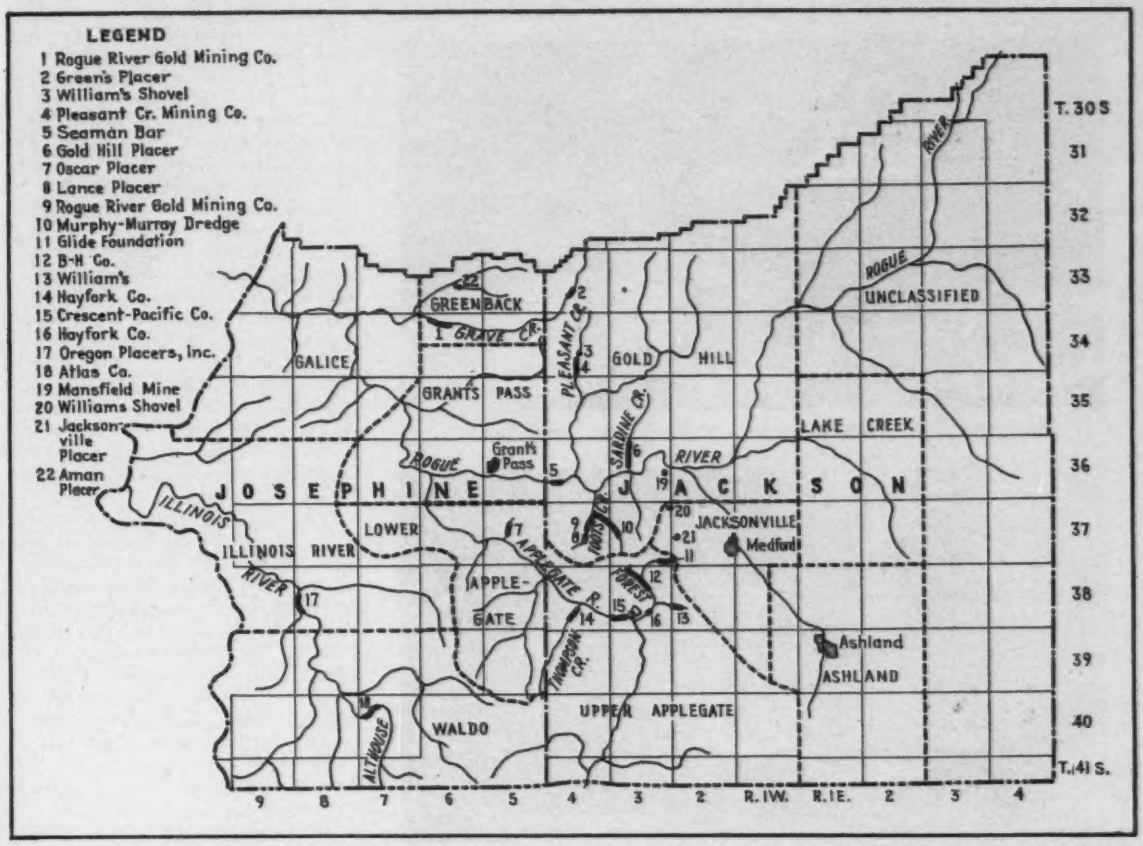
▼ ▼ ▼

Safety Hook For Shaft Sinking

A SAFETY HOOK devised for use in connection with shaft- or winze-sinking operations at a gold-silver mine in Central Mexico is shown in the accompanying illustration. It is designed to facilitate the speedy exchange of the empty for the full bucket, if an automatic dumping device is not available, and providing at the same time a safe means of attaching the bucket to the hoist rope.



As will be seen, the device consists of a hook with a clevis on the upper end and a pivotal lock bar on the lower end, forged from 1¾-in. steel. Closing of the hook is effected by pushing a steel lock ring over the upright portion of the pivotal lock bar resting in a shallow groove milled into the hook stem when in a locked position. The full bucket in this case weighed about 800 lb.



Map of Josephine and Jackson Counties, in southwestern Oregon, showing the respective situation of 22 dredging areas. Of these thirteen were active in recent months. The county subdivisions are mining districts

GOLD DREDGING in Southwestern Oregon

Ray C. Treasher
Field Geologist
Oregon State Department of Geology and Mineral Industries, Portland, Ore.

DREDGING of placer ground is a comparatively recent addition to mining activity in southwestern Oregon, and practically all of the work is confined to Jackson and Josephine Counties. In the spring of 1940 there were 22 areas that had been or were being dredged. Thirteen of these are active, including two connected-bucket-line dredges, five dragline floating washing plants, and six power-shovel excavators. The accompanying map shows the dredged areas in the two counties mentioned. The numbers on the map and legend refer to the following properties:

The Rogue River Gold Mining Co. (No. 1 on the map), of which D. H. Ferry, of Rogue River, Ore., is manager, has a connected-bucket-line dredge on Grave Creek. It operated in Secs. 4 and 5, T. 34 S., R. 6 W., between Leland and U. S. Highway 99. The gold was concentrated on bedrock and when the bedrock dropped beyond minable depths, the operation was discontinued. This was in 1939.

Green's Placer, numbered "2" on the map, is leased to F. S. Green, of Rogue River. It is situated in Sec. 20, T. 33 S., R. 4 W., on upper Grave Creek, where about 40 acres of virgin ground are held by location. The plant was installed in the fall of 1939, but no work was done until late in the spring of 1940. Equipment consists of a dragline scraper and a dry-land washer. Water is available for about nine months of the year. Bedrock is hard, rough slate and diorite. There are many large boulders but no clay is present. The gold is clean and is concentrated on bedrock.

Williams Brothers moved a 1-cu.yd. Marion steam shovel on to upper Pleasant Creek early in 1939 in the W½ Sec. 22, T. 34 S., R. 4 W. This is shown at "3" on the map. The plant ran a few days only and later was moved to Bishop Creek. No. 13 and No. 20 are related operations.

The Pleasant Creek Mining Co., of Rogue River, has a 3-cu.ft. connected-bucket-line dredge on Pleasant Creek, a tributary of Evans Creek, north of Rogue River. Its situation is marked by No. 4 on the map. The company controls about 600 acres in Secs. 21, 22, 27, and 28, T. 34 S., R. 4 W. The dredge is of the flume type. A 110-hp. diesel engine furnishes power for the steel-hull boat and also drives a 15-kva. generator. At present, the dredge is mining the main stream channel. Settling ponds take care of the mining mud. Bedrock is decomposed "granite"; boulders are small; gold ranges in size from fine to coarse and is concentrated mostly on bedrock. The mining width is 600 ft.

Seaman bar (5) is leased to Fred Johnson, of Grants Pass, Ore. The property consists of 115 acres in the

The Hayfork Co.'s dragline and floating washer on Forest Creek (No. 14)

At the Lance placer (No. 8). The Southern Oregon Mining Co.'s diesel dragline serves a dry-bank Bodinson washer. Bucket capacity is 1 cu.yd. The plant can handle 60 cu.yd. per hour

SW¼ Sec. 20, T. 36 S., R. 4 W., on the Rogue River flood plain. A 1-cu.yd. Thew shovel dumps into a dry-land plant that is mounted on wheels. Water is pumped from the river.

The bedrock is cemented gravel. Boulders will average 18 in. in diameter; a few are 4 ft. in diameter. No clay occurs. Gold is fine and well scattered through the gravel. The depth will average 30 ft. The lessee estimates that there is 30,000,000 cu.yd. of minable gravel.

Gold Hill placers, numbered "6," are leased to M. L. Howell and Raymond Calhoun, of Rogue River. The minable ground extends for 1¼ miles along Sardine Creek in Secs. 5, 7, and 17, T. 36 S., R. 3 W. A 1¼-cu.yd. Lorain gas shovel dumps into a dry-bank Bodinson washer. All equipment except the shovel is electrically operated.

Workable ground ranges in width between 500 ft. at the downstream end and 150 ft. near the upper end. Gravel averages 6 ft. in depth, with little overburden. There is an estimated 750,000 cu.yd. of minable gravel. Operations began in April, 1939.

Oscar placer, on Oscar Creek in the center of Sec. 22, T. 37 S., R. 5 W., is owned by D. O. Hayes, of Grants Pass. It originally was worked by hydraulic methods. It is numbered "7" on the map. In 1934, Bolton Brothers operated a washing plant and a large steam shovel on it. Three years later, Bishop and Sturtevant worked it with a 1½-cu.yd. Marion electric shovel and a washing plant, the latter being electrically operated. The property was inactive in 1940.

Lance placer (No. 8) is operated by the Southern Oregon Mining Co. in the SE¼ Sec. 22, T. 37 S., R. 4 W., on the upper Right Fork of Foots Creek. It was worked as a hydraulic mine for years. From May to June, 1938, it was worked by E. B. Bishop, of Orland, Calif., and from January to June, 1939, Von der Hellen operated a washing plant. The Southern Oregon Mining Co. moved from Poorman Creek (see also No. 11) in July, 1939, and began mining in January, 1940.

A 1-cu.yd. Marion diesel dragline with a rated capacity of 60 cu.yd. per hour serves a dry-bank Bodinson washer.

The placer is in a narrow mountain gulch with a dredgeable channel about 150 yd. wide. Bedrock is medium-hard porphyry. There are many large, subangular boulders and some clay. The gold is about 50 percent coarse and occasional $6 nuggets are found.

D. H. Ferry is manager of the Rogue River Gold Mining Co. (No. 9 on map). The company dredged the Right Fork of Foots Creek to the lower end of the Lance placer, and the Left Fork of Foots Creek. The work was discontinued and the dredge moved to Grave Creek. No. 1 is another operation of this company.

Murphy-Murray Dredging Co., of Rogue River, shown at "10" on the map, controls 1,030 acres in Secs. 6, 7, and 18, T. 37 S., R. 3 W., and Secs. 1, 12, and 13, T. 37 S., R. 4 W., on the Left Fork of Foots Creek. Portions of this ground were worked by the Black Gold Channel and C. R. C. hydraulic placers, and the Rogue River Gold Mining Co. and Bishop and Sturtevant dredges.

The boat is of 4,000 cu.yd. capacity and is an all-electric, connected-bucket-line dredge, with 3½ ft. buckets.

Bedrock is medium hard slate, most of which can be dug with the bucket line. There are a few boulders up to 500 lb. The gravel averages 18 ft. in depth, with values scattered throughout it. Most of the gold is coarse, and several large nuggets have been recovered in the nugget trap.

In 1938, on Aug. 23, the Glide Foundation began work on Poorman Creek in Sec. 7, T. 38 S., R. 2 W. (No. 11 on the map.) The creek was then dredged with a dragline and a floating washer between the Applegate highway and the Sterling road. The equipment has been moved to the Lance placer, on Foots Creek. (See also No. 8.)

The B-H Co., which is addressed at P. O. Box 1091, Medford, Ore., and is situated at "12" on the map, is operating a dragline dredge along Forest Creek, in Jackson County, in Secs. 4, 5 and 6, T. 38 S., R. 3 W., and Sec. 32, T. 37 S., R. 3 W. Most of the land is patented. Former holdings in this locality were known as the Alaska of Oregon; the Christian-Dobbin; the Green placer; and the Sturgis placer.

The company has a 1½-cu.yd. Atlas-Imperial dragline and a diesel-powered Bodinson washer.

Dredgeable ground is 150 yd. wide and 10 ft. deep. The overburden is 5 to 20 ft. deep along the margin, or rim, of the channel. Ten percent of the boulders are over 2 ft. in maximum dimension. The bedrock is hard schist. There is little clay. Gold is distributed throughout the gravel and is of medium size and well worn, and is reported as 850 fine. Settling ponds take care of the mining mud.

The washer of Williams Brothers, of Jacksonville (No. 13 on the map) is in the SW¼ NW¼ Sec. 30, T. 38 S., R. 2 W., on Bishop Creek. There are 1½ miles of creek bottom that has about 100 yd. of minable width. The plant previously ran on gravel mined

on Willow Creek (see No. 20) and on Pleasant Creek (see No. 3). Work began the middle of March, 1940.

The washer is a dry-land plant. A ¾-cu.yd. Bay City gas shovel and a 1-cu.yd. Marion steam shovel are used.

Bedrock is diorite, both hard and decomposed. It is quite uneven. There are a few boulders but none too large to handle. The gold is coarse and rough.

Hayfork Gold Dredging Co. began work on Thompson Creek (numbered "14" on the map) in Sec. 22, T. 38 S., R. 3 W., in January, 1940. All equipment was diesel-powered. The 1¾-cu.yd. dragline dredge dumped into a floating plant that has a rated capacity of 2,500 cu.yd. daily.

Bedrock at this place is soft, decomposed conglomerate with some "porphyry." Gold is scattered throughout the gravel and is reported as 870 fine. There are few boulders and but little clay. The company dredged a narrow channel through the length of the leased ground.

On April 25, the outfit was moved to Forest Creek (No. 16) in the SE¼ of Sec. 22, T. 38 S., R. 3 W., about half a mile north of Ruch.

Two hundred acres of deeded land in Sec. 29, T. 38 S., R. 3 W., have been leased by Crescent-Pacific Gold Mining Co., of San Francisco, from Ray Offenbacher and others. The property is on the Applegate River below the mouth of Forest Creek. It is numbered "15" on the map. Work began in July, 1939. A 1-cu.yd. dragline dumps into a diesel-powered floating plant. Bedrock is decomposed "porphyry." Overburden, 4 ft. deep, is stripped and used for resoiling, as required by the lease. Boulders are scarce. There is little clay. Gravel is tight. The gold is coarse and is reported to be 875 fine.

Oregon Placers, Inc., of Selma, Ore. (No. 17) controls property on the Illinois River below the mouth of Josephine Creek in Secs. 19, 29, and 30, T. 38 S., R. 8 W. It was known formerly as the Old Ray property. Equipment consists of a gasoline-electric shovel and a washing plant using Pan-American jigs. It has a rated capacity of 2,000 cu.yd. daily.

The largest dragline plant in southwestern Oregon is that of the Atlas Gold Dredging Corp. The property (at "18" on the map) lies along Althouse Creek in Secs. 4, 7, 8, and 18, T. 40 S., R. 7 W., and includes in part the old Leonard placer. Plant construction began Jan. 20, 1940, and mining about Feb. 7.

Equipment consists of a Bodinson washing plant with a rated capacity of 6,000 cu.yd. daily. Digging equipment consists of a diesel-electric Marion walking dragline with a 5-cu.yd. heavy-duty Esco bucket.

The minable channel has a width of about 500 ft. over a distance of 2½ miles. Bedrock is predominately soft, decomposed granite with a few serpentine "reefs." Most of the bedrock can be cleaned. Overburden will average 6 ft. in depth and consists of barren soil. There is no clay. Boulders that are 18 in. in diameter are classed as "large."

The Mansfield mine ("19" on the map) is at the center of Sec. 30, T. 36 S., R. 2 W. The equipment consists of a dry-land washing plant with a ½-cu.yd. Lorain "35" shovel. Two dump trucks carry the material to the washer.

The gold is rough and varies in size, with no particular concentration on bedrock. Minable depth is 3 to 6 ft. There is some clay and mud, but no water-worn gravel; loose material is probably slump from the hillsides. The area is famous as a "pocket" country and it is assumed that the gold is local in origin.

The shovel operated by Williams Brothers and referred to in the fourth paragraph of this article worked for a short time on ground just west of Willow Creek in Sec. 6, T. 37 S., R. 2 W., on a portion of what was known as the Winchester-Houston placer. After one season here, the plant was moved to Pleasant Creek (No. 3) and later to Bishop Creek (No. 13).

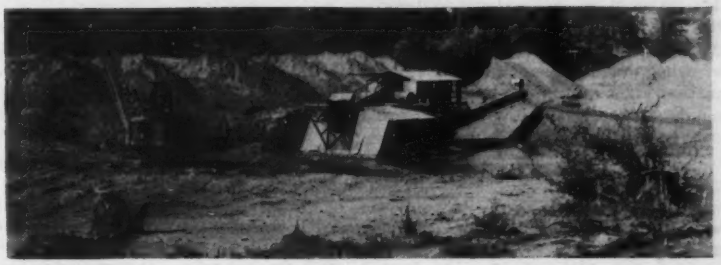
The Winchester-Houston was one of the first placers worked in the Jacksonville district. Most of it has been hydraulicked. In 1940, the bedrock was being cleaned by "snipers."

An area (at "21" on the map) in the northwest part of the town of Jacksonville has been dredged by a dragline, the gravel being washed in a dry-land plant. No further data are available.

On lower Coyote Creek just south of the community of Wolf Creek, in the NW¼ SW¼ Sec. 23, T. 33 S., R. 6 W., is the Aman placer, owned by Gene Aman. It is numbered "22" on the map. Of the 40 acres of patented land, five acres were dredged by the Carlson and Sandberg outfit in 1937. The property has been idle since then.

The floating plant was a Bodinson washer; both it and the dragline were electric-powered. The plant had a capacity of 3,000 cu.yd. daily.

Dragline and diesel-powered floating-washing plant of the B-H Company on Forest Creek, in Jackson County (No. 12)



Atlas Gold Dredging Corp's walking dragline and washing plant (No. 18), here seen on Althouse Creek, is the largest installation of its kind in southwestern Oregon

The Murphy-Murray Dredging Co.'s connected-bucket-line dredge on Foots Creek (No. 10). The dragline in the background is used for stripping

SALTING

The nefarious "art" and its age-old results as practiced on the mining fraternity. (First part of a series)

T. A. Rickard

SALTING is a pseudo-technical term for the artificial, and nefarious, enrichment of ore. Such deceptive treatment may be applied to ore in place, as well as to samples taken for the purpose of ascertaining the average contents of a lode; and a similar trick may be played on ore fed into a mill that is being used for making a large-scale test of the quality of the mine output. The purpose, in each case, is to deceive the person or persons, usually engineers, delegated to appraise the value of the mine. As Bret Harte remarked: "The ways of a man with a maid be strange, yet simple and tame to the ways of a man with a mine when buying or selling that same."

Modern tricksters find their prototypes in some of the so-called alchemists, who were very ingenious in their malpractice. They would use a crucible that had a false bottom made of powdered bone-ash held together by wax or gum; underneath they secreted some salt of gold or of silver. When the crucible was charged and heat applied, the false bottom disintegrated, the salt of gold or of silver was reduced, and when the operation ended some precious metal was found that apparently resulted from the smelt.

Sometimes the gold or silver was stuffed into a hole in a piece of charcoal. The hole was then closed with wax. At other times the charcoal would be soaked in a solution of precious metal, or a hollow rod that contained gold or silver in reducible form would be used to stir the charge in the crucible. The wax that served to close the bottom of the hollow rod would melt, thus permitting the gold or silver to be introduced unseen.

Other tricks included the use of a solution of silver in nitric acid or of gold in aqua regia, or of an amalgam of either precious metal. Any of these when added to the charge, by means of a hollow rod, for example, would supply the requisite metal. A common exhibition was to dip nails in a liquid, and take them out evidently converted into gold. The nails consisted of gold soldered to the iron, and carefully covered with a pigment, which the liquid removed. They would also solder gold to silver, and then whiten the gold with mercury; when the golden half was dipped into the transmuting liquid and the metal heated, the mercury was vaporized, and the gold became visible.[1]

Some of the methods employed in salting mines have been amusingly crude. For instance, a mine near Virginia City, in Nevada, contained ore in which lumps of silver were distributed. The presence of native silver in veins is not unnatural, but usually the metal is in the form of moss or wire, and sometimes in tabular shape. In the instance cited the silver occurred in rounded pellets like nuggets, and the occurrence therefore awakened suspicion. On careful examination the engineer discovered that one of the pellets bore the letters E PLUR, and any loyal American would recognize the broken phrase as part of the motto E PLURIBUS UNUM. In short, the ore had been salted with pieces of silver dollars that had been hammered into the form required to perform the trick.

If the vein matter is soft, and especially if the richest part of the vein is accompanied by clay, it is easy to salt it by shooting an enricher into it. For example, a small mine, consisting of a tunnel or drift a hundred feet below the outcrop, was for sale, in British Columbia. It looked like a promising prospect. The outcrop showed some free gold; the breast of the level exhibited three feet of apparent ore, with soft mineral and a streak of clay; the ore exposed overhead along the roof of the level, for a distance of two hundred feet, from the entry to the working face, was similar in size and character to that exposed in the breast of the level. If the ore was of moderate richness, the showing gave the promise of a good little mine. A competent engineer made an examination. The ore was sampled at intervals of five feet and the assays indicated gold contents of fairly uniform distribution—about two ounces per ton. With gold at $20 per ounce, there seemed to be at least $80,000 worth of ore assured, and, apparently, there was a probability of developing more such ore easily, because the two samples from the breast gave assays of 1.60 and 2.85 oz. respectively of gold per ton.

The engineer that made the examination was suspicious; why should the owners, two prospectors, sell the mine at such an early stage of its development when obviously the further work to be done during three or four more months might easily double the sale-value of the mine? Like the Irish Member of Parliament, the engineer smelt a rat, he saw it floating in the air, and he proceeded to nip it in the bud! He examined some of the ore under a powerful magnifying glass and detected several particles of free gold. These were not crystalline, as is usual in nature, in a vein, nor was their color like that of the gold visible in the outcrop. The color was less pale, less yellow, more reddish. Moreover, the gold, when tested by his penknife, was not as soft as native gold is normally. He knew how to assay; so he made a bullion assay, with the result that the gold proved to have the proportions of silver and copper customary in British coinage—namely, 916.66 per thousand of gold, and the rest copper, with a trace of silver. The pieces of gold in the ore were small, of nearly uniform size, and showed abrasion. They had been made by filing sovereigns, and then they had been shot into the ore by means of a pistol. The engineer said nothing to the prospectors about his discovery of their fraud; he contented himself with telling his client not to buy the property.

Abbot A. Hanks told me a com-

[1] Thomas Thomson: "History of Chemistry," Vol. 1; 1830.

panion story. A promoter came to his father's assay office with a sample of about fifty pounds of sandstone in lumps of egg size. He stated that the ore came from a bluff on the Wilamette River, in Oregon. When crushed and assayed, the sandstone proved to contain $20 in gold per ton. This result was surprising, and provoked suspicion. The promoter suggested a trial by panning, whereupon the gold was proved to be in the sandstone. But the gold looked off color. When the promoter had gone, the assayer, Mr. Hanks, panned some more of the ore and then examined the gold under a microscope. It could be seen that the particles of metal were filings from gold coin, and that accounted for the reddish tint, because the gold coinage of the United States contains 10 per cent of copper, to harden it. Some of the sample that had not been crushed was scrubbed with a brush. The assay then showed only a trace of gold. Another assayer had obtained $20 in gold per ton from a similar sample. The salting had been done cleverly. The promoter dipped his pieces of ore in a dilute solution of mucilage over which his gold filings had been sieved so as to distribute them thoroughly.

John B. Farish, a notable engineer in his day, told a somewhat similar story.[2] It was his practice, as he was born among the gold mines of California, to test the ore by aid of a Mexican horn-spoon. The method, of course, was like panning on a small scale. The mine in his story was at Breckenridge, Colorado, a locality famous for its beautiful specimens of crystalline gold. The vein was a dike of porphyry that had been so decomposed as to consist largely of clay. In his spoon tests he noted that the gold particles varied in color and density, although the assays of his samples gave fairly consistent and satisfactory results. When he returned to Denver, he borrowed a friend's microscope and examined the gold collected by his hornings. Some of it showed abrasion and by its color suggested to him that it was the filings from the old brassy-looking five-dollar gold pieces that were coined at New Orleans many years previously. On enquiry he ascertained that the owner had once been rich, and was now poor, so that, despite a former reputation for honesty, there was a chance that in his desperation to retrieve his fortune he might do anything. Farish returned to the mine with two trustworthy miners. He made cuts into the sides of the drifts, so as to tap untouched ore. He also blasted the ore in other places for the same purpose. His samples from all these places returned only two or three dollars of gold per ton, and in every sample the gold was uniform in appearance and character. It was the natural metal. The brassy abraded particles were absent. To test the matter further, he decided to make a mill-run. He sampled the ore as it was broken in the mine, when it was hoisted in the bucket, when it went through the crusher, as it came from the feeders, and, finally, he sampled and tested the tailing from the mill. All these tests served to circumvent any trickery, and the results uniformly proved the low grade of the ore. Many years later the manager of this mine when dying told the truth of the transaction and bemoaned the costliness of the attempted salting. A shot-gun had been used to inject the filings from the coins into the soft ore.

Ordinarily one regards the agent of an express company as honest. He would not, it might well be thought, hold his post if he were suspected of being otherwise. One would not therefore be likely to suspect him of being a confederate of nefarious mine owners. John Farish, whom I have already cited, tells how he took pains to prevent salting when he was examining a mine in southwestern Navada.[3] He brought with him a strong box in which he placed his sampling equipment. This included a number of twill bags, together with tape of a peculiar green tint and a sealing wax of an unusual kind. He was accompanied by two assistants. Whenever the box, in which the samples were duly placed, was out of sight, as at meal hours, it was tied with the tape and sealed with the wax. No one was near him or his aids when the samples were broken in the mine. Every precaution apparently had been taken. At last, the examination having been completed, the three men and the box went in an open wagon to the railroad station at Candelaria. The Pullman conductor would not allow them to take the box into the sleeping car, so they seated themselves in the day coach and put the box beside them. In the evening the train stopped at a station for supper, and, in order to enjoy their sleeping berths, Farish decided to entrust the box to the express company and have it forwarded direct to the assayer in San Francisco. The box was bound with the tape and duly sealed, but the express agent said that the rules of his company did not allow him to accept a box so sealed, whereupon Farish procured some screws and fastened the cover securely, after removing the tape. When the samples were assayed in San Francisco the results were surprising; the ore contained about twice as much gold as Farish had expected. This led him to test, by assay, some of the choice pieces of ore that he had picked up while at the mine. These proved to be no richer than the average ore. His suspicions were aroused. He returned to the mine and took a few check samples, none of which left his possession even for a moment. These, when assayed in San Francisco, were shown to be as poor as he had anticipated. The express agent had done the trick. To do it he must have been in close collusion with the owners of the mine. It seems likely that one of them was on the train awaiting an opportunity to salt the samples, and, when he saw the box was left with the express agent, he left the train, remaining behind so as to carry out his nefarious purpose, after having bribed the express agent.

Farish tells yet another good story illustrating the trickery of unscrupulous mine owners. Mark Twain said that a mine was "a hole in the ground owned by a liar." It looks as if he himself had been victimized. On the other hand, Bret Harte said "that for ways that are dark, and for tricks that are vain, the heathen Chinee is peculiar." He was referring to the game of cards in which Ah Sin, whose smile was pensive and childlike, had placed wax on his finger nails, and in his sleeves, which were long, he had secreted 24 jacks, "which was coming it pretty strong," as Bret Harte remarks, but we may well think that the narrator was "coming it pretty strong" when he credited the Chinaman with the use of 24 jacks, when obviously, two or three would amply suffice for his nefarious purpose. In other words, Ah Sin would resemble the salter that enriches the ore excessively and thereupon provokes prompt suspicion.

Farish, in his third story, was examining a silver mine near Fairplay, in Colorado. The lode was an impregnation of silver in limestone, and the ore was alleged to contain 18 to 24 oz. of silver per ton. When he went underground he was not favorably impressed; nevertheless, he took his samples carefully and sealed the bags

[2] John B. Farish: *Mining and Scientific Press*, Vol. CX, p. 578.

[3] *Ibid.*, p. 577.

with a ring bearing an Old English F. The samples were put into a large canvas sack, padlocked, and then delivered to the express company at Fairplay. He had taken the usual precaution of breaking a few lump specimens of ore and had secreted them in his baggage. When the samples were assayed, at Denver, the results confirmed the statement of the owners, two brothers. The average content was from 15 to 20 oz. of silver per ton. But two of Farish's choice pieces assayed 12 oz. He dropped the business.

Shortly afterward the mine was sold for $300,000 to an English company. A small mill was erected forthwith and the output soon proved that deception had been practiced. Several months later a distinguished lawyer, Charles S. Thomas, asked Farish to call at his office, in Denver. Farish was told that his samples had been salted, as he had suspected. When the sack of samples was handed to the express company, the younger brother of the two owners had gone to the express office and he, with the agent, had carried the sack to a deserted cabin near by. There they had forced open the sack, and, finding the bags sealed, had injected a liquid enricher by means of a syringe through a hole made in the bottom of each bag. They expected Farish to return for a second examination, and they therefore took a wax impression of his seal and caused a duplicate to be made for them at Chicago.

The rest of this story is told by Walter McDermott, an honored member of the mining profession.[4] He examined the same mine for the English company to which reference has been made. While McDermott was the owner of a testing mill and assay office in New York, a friend of his, an English mining engineer, brought a series of samples for assay and also half a ton of average ore for a mill test. These samples had come from a silver mine in Colorado. "The samples came out very well, the milling test showed no difficulty in treatment, and the engineer's report to his English principals was quite a glowing one." Nevertheless, for financial reasons, the mine was not purchased by the people in London, and a year later the owner called on McDermott to discuss a sale of the property. An offer of $300,000 (as mentioned in connection with Farish's story) was made on behalf of another English company, for which McDermott acted, but the transaction was subject, of course, to a fresh examination of the mine. Meanwhile McDermott had received a report from a mining engineer resident in the West, confirming the owner's assertions regarding the quality and quantity of the ore available in the mine. Further, he, McDermott, had received copies of statements by two other Western engineers, indicating that the mine would prove more profitable if all the output were worked by a milling process instead of selected ore being shipped to the smelters as heretofore. Already the evidence seemed ample and convincing. However, McDermott visited the mine himself and sampled it carefully, as he records, "taking some 1,200 lb. of samples, and sealing the sacks in the mine by wire through and round the necks, and held by a special lead seal of my own." Here again we see an experienced engineer in action.

The ore occurred in a bedded deposit about six feet thick, which, outside occasional pockets of richer stuff, was reported to average from 30 to 50 oz. of silver per ton. Previously the picked ore had been sent to the custom smelters; the question was whether better financial results would not ensue from treating the whole width of the lode in a mill. What then was the content of the poorer stuff? Therefore, in addition to 26 average samples, McDermott took "seven special full-sack samples from different parts of the mine, each of which consisted only of large lumps of the poorer ore, without any fine admixture." His intention was to clean these lumps of ore when they reached his assay office, and thus protect himself against any salting by the introduction either of pulverized mineral or liquid enricher into the sacks after they had been sealed.

"My little program, framed for my own protection, was in an evil moment slightly changed, and thereby ruined. Owing to pressure of inquiry for a preliminary report, I decided to crush five of my seven test samples in a neighboring sampling works, and so satisfy myself as to the lower grade of ore, which would determine the probable value of the mine for me. I took every precaution by cleaning up the crusher and rolls myself, and dusting off the lump samples, and crushing and quartering down to the assay samples, which I took in duplicate. One of the sets of samples I gave to a local assayer, who was, I knew, interested, and would not have been, of course, reliable if unchecked. The second set of samples I kept myself in a valise in my bedroom. Subsequent reports from a Pinkerton detective that had been sent by me to reside and work at the mine, showed how these private check samples were got at, how a duplicate of Farish's seal had been made, and how the whole mining camp was honeycombed with a six years' standing conspiracy. I had still in reserve the two other lump samples sealed as taken, and which, with the other 26 average samples, were sent on to New York to await my return. As bad luck would have it, however, I was stopped by a telegram on my return, and had to go farther west to examine another mine; and the samples arriving before I did, they were crushed and assayed by my assistant in New York without the special precaution necessary, for the two lump samples, of cleaning before crushing." At night the agents of the vendor injected into each of the sacks, containing the samples, a dose of finely divided silver precipitate, which could be purchased at that time from leaching plants using copper-plate precipitation of silver. During the crushing and mixing, before the assay samples were taken, this 'salt' became thoroughly incorporated, as appeared subsequently in the assay results. Later investigation showed that whereas the lump samples of the low-grade stuff contained naturally only 2 or 3 oz. of silver per ton, they assayed 20 to 30 oz. after they had been duly doctored.

"A lawsuit ensued, and some facts were elicited because the express agent had not been paid his share of the loot and therefore turned against his companions in crime. I submitted in evidence some microscope slides showing the fine artificially produced silver, which could be panned out of the samples that had been assayed by me. The reports of the detective were damning. Eventually the Court of Appeals in Detroit, Mich., decided in favor of the plaintiffs, giving them judgment for all they asked. The title of the case was the Mudsill Mining Company Limited v. Watrous et al. The decision was dated Feb. 5, 1894."

Thus an engineer of wide experience was beaten by a combination of untoward circumstances despite his intelligent precautions. The perpetrators of the fraud were assisted, as often happens, unwittingly, by the engineer's principals, because they pushed for a completion of the purchase, and ignored any chance of error in view of previous favorable reports by other engineers. Nevertheless, a few days after the completion of the purchase, McDermott sampled the mine again, and the first assays of the lower-grade stuff made it clear to him that there had been a successful salting of the ore; whereupon he cabled immediately to his principals and started on the toilsome task of bringing the gang to account. Ordinarily it is difficult to obtain legal proof of such malfeasance, but owing to the kind of "salt" introduced into the samples, he was able to separate the silver and prepare an exhibit of microscope slides; this, together with much circumstantial and detective evidence, collected little by little, enabled him, after four years, to obtain a sweeping judgment against the vendors of the mine.

(To be continued)

[4] *Transactions of the Institution of Mining and Metallurgy*, Vol. III, p. 125; 1894.

Operating Characteristics of Mechanical Flotation Machines

An analysis of the influence of aeration, agitation, distribution of air, circulation of pulp, and mechanical design, with some suggestions for improvements through simplification

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THE CHEMICAL ASPECTS of the flotation process have been intensively studied. As a result, its basic mechanism is well understood and the subject has been comprehensively presented in several recent books as well as in the many papers in periodicals. Yet, little has been written within the last 15 years that makes thoroughly clear exactly how a flotation machine works. Just what are the factors that determine its capacity? Its ability to aërate properly? Its characteristic power consumption? Just how much agitation and circulation of pulp is essential? We can formulate superficial answers to all these questions, but how many of us can make these answers serve to give a complete understanding of the separate elements of a flotation machine and their useful functions? Indeed, if we had all the answers there would be no shortcomings in the available commercial flotation machines, and mistakes in their installation would never be made.

An average mine operator shopping for new flotation machines must now of necessity make the choice of any particular type on the basis of salesmanship, prejudice, or simple habit. He will find practically no unbiased data showing operating comparison between different machines. Yet actual field tests on a given ore of half a dozen different machines, each claimed to be superior to the others, are quite beyond the means of any but our largest corporations. Consequently, if the average operator is trying to make as honest a choice as he can, he is faced with the problem of making up his mind in some indirect way. Perhaps a way can be shown through the analytical approach—that is, appraising the potential effectiveness of a particular type of machine from an intelligent examination of its design and specifications. Naturally, to be able to do this one must have a thorough understanding of the way a flotation machine works.

Some New Concepts of Flotation Machine Operation

It has been the writers' good fortune to be involved in the development of a machine during a field test of several available commercial machines in a mill treating a porphyry copper ore. In the course of this test some striking similarities and differences in the various machines became evident; not the similarities and differences of construction and design immediately apparent, but those revealed only in the performance of the machines, and those, therefore, that determine the effectiveness of the machines in operation. Furthermore, it seemed possible to suggest a relationship of such elements as design of tank, of impeller, the manner of introducing and dispersing air. As a result several new concepts of flotation machine operation have suggested themselves that may be found contrary to the accepted opinion regarding them. Perhaps these new viewpoints can provoke a discussion in which both the operators and the manufacturers can take part. A fuller understanding of the subject may thus result, opening a way to a more intelligent application of machines to treatment of ores, and perhaps to the improvement of the flotation machines themselves.

The modern use of the word "flotation" implies flotation by means of air bubbles, and the prime function of the modern flotation machine is to provide proper and adequate aëration of the pulp passing through it. The importance of this function has long been recognized. T. J. Hoover, for example, mentions as early as in 1912[1] the desirability of aëration in flotation pulps in connection with a description of the original Minerals Separation machine. He states, quite correctly, that the M.S. machine owed its superiority to the introduction into the pulp of innumerable small bubbles which thus presented a much larger available surface for flotation than did the large bubble froths or skin flotation processes which characterized earlier practice.

Of importance to the understanding of what happens in a flotation machine is the manner in which air bubbles become attached to mineral particles in the pulp. Taggart[2] has suggested that in a mechanical machine the air is precipitated out of solution onto the surfaces of mineral particles in the form of bubbles; and that, furthermore, this precipitation of air occurs only in the immediate vicinity of the impeller of the machine. This behavior of the air he believed due to the beating of the impeller blades, the action of which drives air into solution ahead of them and precipitates it in the partial vacuum existing behind them. This belief implied the necessity of forced circulation directly through the impeller of all the pulp in order to obtain proper aëration. This idea may have been the contributing fac-

1. "Concentrating Ores by Flotation." *The Mining Magazine*, Salisbury House, London (1912), p. 58.

2. "Handbook of Ore Dressing." John Wiley and Sons, N. Y. (1927), p. 796-799.

tor in causing so many of the manufacturers to build into their machines fairly complicated and expensive provisions for positive circulation of the pulp through the impeller—provisions that are beginning to appear unnecessary. That positive circulation of all of the pulp through the rotor is *not* necessary to secure mineral-bubble attachment is at least implied in the modern consensus on the mechanism of this attachment, which asserts that flotation can occur wherever air bubbles and suitably coated mineral particles may come into contact. In 1932 Gaudin[3] critically examined the gas precipitation hypothesis of Taggart and concluded that the direct bubble-mineral contact explanation is the more plausible one for the prevailing mechanism of flotation. His reasons for so concluding were numerous and cogent and need not be repeated here.

Even admitting the direct bubble-mineral contact explanation, it has been argued that it is essential to pass all the pulp through the impeller, because that is where the highest impact velocities occur, and such high velocities are required to secure proper attachment of all of the floatable mineral to air bubbles. This may apply to a certain extent to some special cases in which the proportion of much finer-than-average floatable mineral is great.[4] But practical evidence is inconclusive to support the view that without positive circulation through the impeller a machine cannot attain its maximum effectiveness. In fact, the success of several modern makes of mechanical flotation machines that do *not* have positive circulation is evidence against it. Indeed, there does not seem to be any good reason why floatable mineral cannot be collected at any point in the cell volume where air bubbles and mineral particles are in motion, provided enough air bubbles are available. It would follow from this that, so long as any given volume in the cell is properly aërated, flotation will take place in that volume. Once this principle is accepted, a significant correlation can be drawn between the aërated volume and the capacity of the machine. The results summarized in Table I are taken from an actual test of three different machines on the same ore, giving comparison between their cell volume, estimated *aërated* volume, and capacity. The agreement in the capacity per cubic foot of aërated volume shows that capacity of flotation machines is directly proportional to their *aërated* volume, and not to the total cell volume. It must be borne in mind, however, that this volume must be properly aërated, as those portions of cell volume that are devoid of air or in which air is but poorly dispersed are ineffective and of no significance in computing capacity.

"Effective Volume" Determines Capacity

These statements are not hypotheses. They have been learned by experience that has indicated their truth. A flotation machine was actually built which, by means of a large tank volume beneath the comparatively small aërated zone, sought to obtain large capacity. It was felt that because time of contact in the cell determines its capacity, the larger tank volume would increase both. It was found, however, in parallel competitive tests with other machines, that the large tank volume below that aërated zone did not contribute to increased capacity. Good metallurgical results were obtained with this machine, but at a very much smaller capacity than that indicated by the time of contact calculated on the basis of the total volume. When the volume below the aërated zone was progressively decreased by letting the cells fill up with sand, no change in capacity resulted, and this despite a change in the total cell volume from 113 to 60 cu.ft. In the light of the foregoing discussion it is proposed here that capacity of a flotation machine is determined by its *effective volume*, when this term refers to that volume of pulp in a mechanical flotation machine which is thoroughly charged with air while the machine is operating. The derivation of the term is simple. It has already been pointed out that flotation can occur only in the aërated portions of the pulp in a machine, and only the volume so aërated can be considered effective in permitting flotation. This suggests the term *effective volume* of a machine as that determining its metallurgical capacity. The use of this term will avoid possible overestimates of the capacity of a floatation machine based simply on the total cell volume.

Figs. 1, 2, and 3 illustrate diagrammatically how the effective volume can be estimated. Fig. 1 represents a cell of which the total cell volume is very large. The crosshatched portion of the cell is the only part which is charged with air; hence, the effective volume. Below the aërated zone the pulp settles, is de-aërated, and recirculated, but because there is no air in this zone, there can be no flotation. Fig. 2 represents the same type of cell, same effective volume, but much reduced in total tank volume. The metallurgical results are the same even though the retention time of the pulp within the cell in Fig. 1 is greater. Fig. 3 shows a point which must not be overlooked in estimating effective volume. Impellers of large size or of high speed tend to throw air out to the sides of the machine. The central portion of the pulp may thus be left practically barren of air, and hence cannot be included as effective volume. Care must also be exercised in evaluating a deep cell of the air-lift type. Fig. 4 shows such a cell and its effective volume (cross-hatched). Obviously the action differs from the cell shown in Fig. 1 only in the motive power for circulation of pulp. It should be noted that the volume inside the air-lift column is only partly effective because air is not properly conditioned here. Once the nature of effective volume is perceived and accepted, it is clear how it can be increased in order to secure greater capacity. Experimentally, this was done in a mill test by raising the sides of the machine so that the total aërated volume of pulp over the impeller was increased. Table II shows the result of this change when compared with another competing machine whose operation was unchanged during this time. Recovery was equally good in the two tests.

Because of the improvement noted, the effective volume was still further increased by lowering the impeller (source of air) in the tank. The results were encouraging until finally a point was reached when further increase of depth of impeller resulted in a decrease of efficiency. Investigation showed this to be due to a breaking down of the dispersion of air in the

3. "Flotation." McGraw-Hill Book Co., N. Y. (1932), p. 95–98.

4. "Flotation." A. M. Gaudin (1932), p. 88–92.

Table I—Comparison of Cell Volume, Aerated Volume, and Capacity of Different Machines

Machine	A	B	C
No. of cells in the bank of rougher cells compared	10	10	9
Total volumetric capacity of rougher cells, cu.ft.	650	675	480
Total estimated aërated volume, cu.ft.	480	320	280
Capacity of installation, tons per day	850	600	500
Capacity per cu.ft. of total cell volume	1.31	0.89	1.04
Capacity per cu.ft. of aërated volume	1.77	1.88	1.78

Table II—Influence of Increased Effective Volume on Capacity

	Test 1	Test 2
Effective volume, cu.ft. per cell	24.5	31
Maximum tonnage treated, tons per day per cell	53	64
Capacity per cu.ft. of effective volume (*a*)	2.17	2.07

(*a*) It should be noted that these figures are somewhat higher than those given in Table I. This is a summary of different period of operation from that summarized in Table I, and somewhat different character of ore was treated during the two periods.

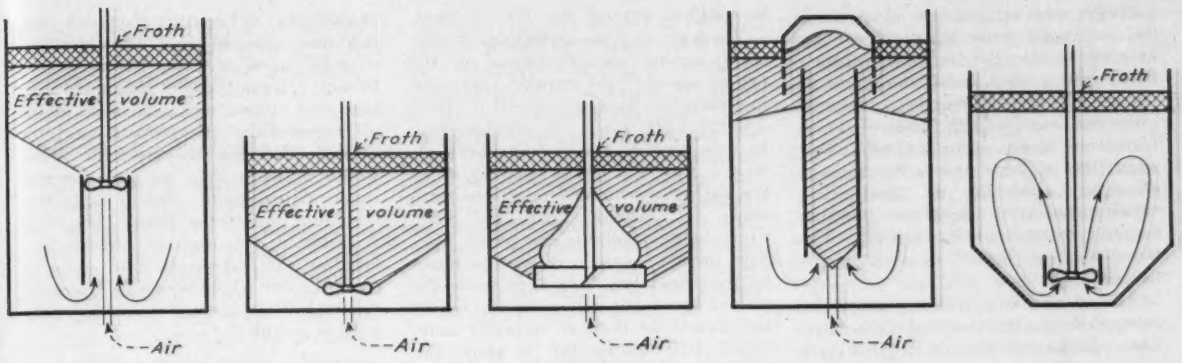


FIG.1 FIG.2 FIG.3 FIG.4 FIG.5

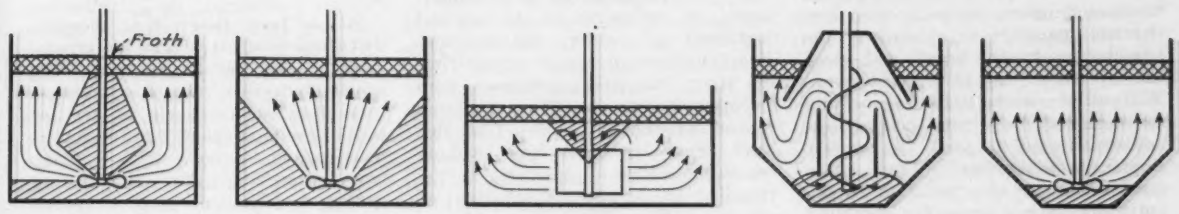


FIG.6 FIG.7 FIG.8 FIG.9 FIG.10

Figs. 1-4—Illustrating "effective volume" of a flotation machine, defined as volume of pulp thoroughly charged with air. Fig. 5—Design of tank to avoid tendency of the machine to "sand up." Figs. 6-10—Various induced direction of impeller flows to secure air distribution

pulp. Large bubbles began to be formed and distribution of the air throughout the volume of the cell became difficult. The effect was to reduce the volume properly charged with air bubbles and to reduce greatly both the number of bubbles and the available bubble surface. Both of these would render the volume partly ineffective in flotation. The danger of forming and consequent boiling up of large bubbles has been recognized by everybody concerned with flotation. Not only is it unsightly, but loss of effective volume ensues, and the air that causes such boiling is wasted. This air does not serve to float anything, but tends to interfere with the flotation of the mineral that is already collected in the froth. At times, when this effect is pronounced, efforts have been made to distribute the stream of large bubbles by means of baffles so that the froth accumulation on the surface of the pulp can conceal the boiling column of air. This method of hiding the defect leaves the cause untouched. The air is still not properly dispersed and the loss in effective volume is still there. When this phenomenon of "boiling" of air is due to an inherent defect in the machine, rather than some temporary or unusual pulp condition, the cause generally is faulty dispersion or distribution of air due to faulty design of the machine's impelling and distributing mechanism. These faults can sometimes be overcome by greater agitation, but a prodigal expenditure of power will invariably result. This method cannot, therefore, be said to be successful if other methods of air dispersion, less wasteful of power, can be found. From the foregoing it is apparent that the effective volume of a flotation machine is a much more significant dimension than mere cell volume. It is believed that the effective volume of all flotation machines may be greatly increased once this matter of air distribution and dispersion is more fully understood and properly applied.

Just what volume of air is required to render a given volume "effective" is a question that can be answered only empirically. Some manufacturers have claimed that 1 cu.ft. of air per minute per cubic foot of tank volume is a reasonable average of the air requirement. From the discussion on effective volume it becomes clear that this empirical requirement should be further qualified. The quantity of air introduced into the machine is of no significance unless the air is properly distributed and the amount of air is expressed per unit of effective volume rather than tank volume. In any case, however, such empirical rating is likely to be misleading because the volume of air required in a mechanical machine will depend primarily on the nature of the ore itself. For example, in floating a high-grade base-metal sulphide ore the froth will be bolstered by quantities of easily floatable mineral, and relatively small volumes of air will be required. The obvious reason for this is that an air bubble in traversing a pulp rich in floatable mineral particles will, under favorable conditions, make contact with enough particles to cover its surface completely. Consequently, the quantity of air required per unit volume of pulp is relatively small. In the case of low-grade ores, however, a bubble may range through the pulp and be released at the surface without encountering a single sulphide particle. Hence, many more air bubbles would be required to contact the sulphide particles in impoverished pulp, resulting in the requirement for much greater volume of air. This relation between air volume and floatable mineral is graphically illustrated in a long line of subaëration cells wherein the amount of floatable mineral in the pulp decreases steadily toward the end of the series. In the first cells, a heavy, well-mineralized froth is obtained with but little air, but in the later cells, which float a pulp impoverished in floatable mineral, the air requirement is invariably greater, to insure optimum recovery.

Agitation a Fivefold Function

Besides aëration, agitation of the pulp is one of the essential functions of a flotation machine. This function is fulfilled by the impeller, which must accomplish a fivefold task. It must supply sufficient agitation to prevent sedimentation of the coarser fractions of the ground pulp; to effect minute subdivision of air; to distribute this air uniformly throughout the zone of effective volume; to secure thorough mixing of air, reagents, and pulp; and to impart sufficient velocity to mineral

particles and air bubbles to produce the maximum probability of contact between them. Yet, in accomplishing these things, the agitation must not be so severe that excessive turbulence of pulp will inhibit or destroy froth formation at the pulp surface. This seems like a large order, yet without effectively achieving all these aims simultaneously, a flotation machine cannot perform its task properly. The impeller is the "heart" of all mechanical machines.

Among machines currently available, many different types of impellers exist. Their design varies widely, yet all are alike in their importance to the successful metallurgical performance of each machine. Moreover, inasmuch as the major power input in most mechanical machines is applied to the impeller, its proper design and speed are of direct economic importance. With all the work that has gone into the design of impellers, their success apparently still depends on purely empirical development. There exists great difference of opinion as to the optimum size and shape for obtaining best results, and no attempt will be made here to evaluate any particular one. That course would lead only to endless and profitless discussion, and, therefore, only the most general considerations of the proper aim of impeller design will be offered.

An impeller must provide proper aëration by subdividing the air into fine bubbles. In modern machines this is done either by the blades of the impeller or by a combination of effects of the rotor and stationary baffles (stator), which shear the air bubbles between them. This function of the rotor and its surrounding mechanism is well recognized by all manufacturers as being absolutely essential, and all successful machines must of necessity incorporate this feature. To the practical man impeller designs are significant essentially in the power a flotation machine consumes. This relative power consumption may sometimes be judged from the construction of the impeller. For example, large bladed impellers may by their shape suggest that they would be excessive in the use of power as compared with a streamlined impeller obviously designed for power economy. This reasoning, however, must be applied with caution, for the large impeller may, at certain critical speeds and with certain volume of air introduced, become "air bound," hence streamlined in effect, and be less wasteful of power. On the other hand, baffling in the vicinity of the streamlined impeller may cause excessive turbulence or constriction of the pulp flow, which may greatly increase its original power requirement. In either case, the best test is, of course, a trial under actual operating conditions, wherein the subdivision and distribution of air may be weighed against the power input.

There exists some semblance of harmony among manufacturers on the proper speed of the impeller, for most impellers are run at a speed of from 1,800 to 2,500 r.p.m. It is interesting to note that this speed has been almost a standard in the industry since the earlier mechanical machines were made, the Janney machine at 3,600 r.p.m. being a notable exception. Perhaps the agreement is due not so much to the fact that this represents the proper speed for achieving the essential functions that an impeller must fulfill, but because this is about the critical speed beyond which the power and the wear factors increase unduly.

One of the more obvious requirements of agitation is to prevent "sanding up" within the machine. Every flotation operator at one time or other has had experience with machines sanding up. When machines exhibit an inherent tendency of this kind, operators often have had to combat it either by speeding up the impeller or by the installation of suitable baffles. However, increasing the speed of the rotor is often dangerous in that it may upset the optimum aëration conditions established by the manufacturer. It is likely that an inherent tendency of a machine to sand up is due not so much to insufficient speed as to improper design of tank. Wide shallow tanks afford large settling area, and it is difficult to maintain a pulp in suspension in such tanks. Sanding up can be prevented only by driving the pulp violently toward the sides of the machine. This would require excessive power input. In a tank having lower ratio of pulp surface to volume, tendency to sand up can be reduced to a minimum by so designing the tank and arranging this circulation of the pulp that the solids in settling tend to gravitate toward the intake of the impeller, which can throw these solids back into suspension. One way of achieving this would be in the manner illustrated in Fig. 5. If circulation of pulp is maintained as shown in the diagram, agitation of the main bulk of volume of the cell need not be great enough to keep the coarser particles in suspension, as these particles can naturally travel toward regions of high pulp velocity (at impeller intake), and be prevented, therefore, from settling anywhere permanently. In this manner power can be used most economically, and agitation kept within the limits demanded by proper distribution of air. Turbulence as a result of such agitation is usually ample for proper mixing of air, pulp, and reagents.

It is believed by some that an impeller must impart very high velocity to the pulp to obtain violent agitation in the aërated zone. Intention of this is thereby to secure a greater probability of contact between the floatable mineral and air bubbles, with the hope of improving recovery. However, some types of machines that lack this violent agitation have stood up successfully in competitive tests against machines featuring it. This would indicate that, at least beyond some critical point, violent agitation is of less importance than is believed. A possible exception to this is the flotation of extremely fine mineral particles, for which it can be reasoned theoretically[4], high velocity of the pulp is essential.

Importance of Distribution of Air

It has been shown that thorough distribution of air within the aërated zone is essential in rendering that volume "effective." In most machines this effort should begin at the impeller itself, so that further aid in distribution be done with a minimum of baffling. Excessive use of baffling to secure proper distribution is objectionable because it tends to complicate the design of the machine, and because there is danger of progressively impairing proper distribution as shape of baffle changes due to wear.

Figs. 6, 7, 8, 9, and 10 show diagrammatically several types of induced direction of currents to secure distribution of air. In these diagrams the arrows show the direction of flow of air, and the cross-hatched areas show the portions of cell volume that are "ineffective" by reason either of absence of air or of high enough velocity of flow away from the surface, so that air is entrained with the flow. Distribution in Fig. 6 tends to localize release of air too much near the edges of the tank, and spitzkasten or extension of the tank have been sometimes used in the attempt to alleviate this tendency. The danger in doing this is that excessive froth surface may require more air than the machine can deliver and distribute. Distribution in Fig. 7 tends to localize the release of air near the center, and results in excessive loss of effective volume. In Fig. 8, distribution shown combats the natural tendency of air to rise vertically, and requires high velocity of pulp to secure such distribution. Moreover, there is the tendency of localizing air at the edges which is the same as that exhibited by the type of distribution shown in Fig. 6. Fig. 9 shows a type of distribution that would tend to give the maximum of violent agitation and mixing of air and pulp, but the direction of flow again is, as in Fig. 8, contrary to the natural tendency of air to rise. In Fig. 10 is shown distribution that would be ideal, provided it be uniform as shown. From the standpoint of

effective volume the types of distribution shown in Figs. 8, 9 and 10, shown on page 47, would be most desirable.

How Much Circulation of Pulp

Many flotation machines for years have been designed to provide circulation of all the pulp up through the impeller of each cell in turn. Pneumatic flotation machines have escaped being bound this way. They were made simply of long open tanks into which air was bubbled. The advocates and operators of cell-to-cell mechanical machines were scornful of these huge "hog troughs" which operated in such an unscientific, hit or miss way, yet for a long time no mechanical machine could compete with one of them in capacity, simplicity, or power cost.

In the competitive test in which the writers were involved there were several machines of individual cell construction, and in which all the pulp entering the cell had to pass through the rotor. One of these was altered by the simple expedient of building a long tank of suitable dimensions, and placing several impellers in line. All ports, conduits, and false bottoms were eliminated. The new rotors were simply suspended in the long trough, and the pulp was turned into it. The results were surprising, not so much in metallurgy, although it was equally good, if not better than before, but in greater ease of control, and in lower power consumption. The rotors were not required to circulate pulp cell to cell; they merely mixed it, prevented sedimentation, and distributed air. The operators no longer had to make frequent compensating adjustments. A pneumatic unit in parallel operation and of lower capacity used four to five times the quantity of air and actually consumed more power per ton. Furthermore, the pneumatic machine was no simpler to control; indeed, at times it was more difficult, because fine adjustments were more difficult with it than with the mechanical unit. Thus it would seem that circulation of all pulp through the impeller of a flotation machine is unnecessary. In fact, construction of a positive circulation machine may be such that on large tonnages it may be seriously handicapped.

To force all the pulp entering the cell through a narrow opening into the impeller limits the potential metallurgical capacity of the machine to its mechanical capacity as determined by the size of the conduit or by the pumping rate of the impeller. On the other hand, the open tank design imposes no physical limits on the machine's capacity, and frees the impeller for the all-important task of subdivision and distribution of air. Furthermore, a very important corollary of the simplicity of open tank design is that such a machine will cost much less to build and can be sold at a lower price than can a relatively complicated individual cell machine of equal capacity. In so far as it is compatible with those factors of aëration and agitation already mentioned, it would seem therefore that mechanical machines, successfully incorporating these simplifications, can begin to compete with pneumatic machines on the same terms that caused the almost universal adoption of the air machine in the flotation of low-grade copper ores.

Influence of Mechanical Design

Apart from the fundamental factors of aëration, agitation, and circulation, there are other elements of a flotation machine which may seriously affect its performance and its desirability. These are the mechanical elements of design, all the dozens of small things that go into a more or less complicated mechanism to insure its smooth and continued operation. Accessibility of controls, proper design of shafting and bearings, elimination of wear, ease of replacement and repair—all these factors have been studied by all manufacturers, and dealt with in their turn. Most of these matters have been well taken care of, and no further mention need be made of them.

The shape of the tank is a feature of design that has been mentioned in relation to agitation and sedimentation within the cell. But the shape of the tank in so far as it fixes the froth area also directly affects metallurgical results. It was discovered in competitive tests that, other things being equal, increase of froth area at the head of a bank of cells increased the grade of concentrate obtainable from the first two or three cells. This was indicated by comparisons between machines of different froth areas, and with varying froth area on the same machine. In all cases the attempt was made to secure as clean a concentrate as possible under the circumstances. A superiority in grade of concentrate of the machine possessing the greater froth area was indicated; and to prove the point further, the froth area of the first cell of one of the machines was increased by 25 percent. Improvement in the grade of concentrate resulted, especially in lowering the insoluble content.

By the extension of this effect, it can be argued that in the flotation of low-grade copper ores there should be a difference in design between rougher and cleaner cells. Because increased froth area aids in securing cleaner concentrate, the cleaner and first few of the rougher cells might advantageously be constructed to incorporate greater froth area per unit of volume than the last rougher cells or scavenger machines. The latter, which treat pulps greatly impoverished in floatable mineral, will have nearly barren froths that tend to break down readily. In breaking down, the froth drops its scant mineral load, and a decreased recovery might result. By decreasing the froth area for a given volume of air, this danger is minimized. It would seem, then, that cells working on pulps impoverished in floatable mineral should have a small froth area but a large effective cell volume to maintain high capacity. Whether or not providing the requisite froth area in the different parts of the flotation circuit is economically justifiable is a matter which ought to be investigated in large-scale mill tests.

It should be emphasized that the foregoing discussion on the effect of froth area upon the grade of concentrate produced is predicated on the assumption that the froth be heavily mineralized. It then becomes clear that the production of cleaner concentrate with greater froth surface depends essentially in allowing the froth to form freely, and drain of interbubble pulp containing gangue; whereas with insufficient area the froth is crowded and the gangue mechanically entrained is carried over with the concentrate.

In the flotation of non-metallics, where a large quantity of mineral has to be floated, large froth areas are essential if grade of concentrate is to be secured. It would appear that machines best suited for this purpose would have a large area in relation to volume, or in other words, be of shallow tank design. In any case, it seems fairly obvious that the tank volume provided should be the maximum possible which the impeller can render effective. Less volume causes waste of power by over-concentration of the effect of the impeller; more volume will merely cause the formation of ineffective zones or excessive sanding up.

In summing up all of the factors mentioned in this paper one is faced with quite a problem. All of the functions of the flotation machine are interrelated to so great an extent that discussion of any one of them will almost certainly involve some or all of the others. It is possible, however, to fix a number of conditions by merely stating two general factors which have been evolved as a result of the analysis presented in this paper. First, it has been determined that the maintenance of a maximum effective volume of pulp within each cell is of prime importance to the greatest metallurgical capacity of a flotation machine. Second, it has been demonstrated that existing machines can be much simplified in method of pulp circulation, power input, cell construction, and control. Moreover, simple means of aëration and agitation seem to be effective, and a way is thus pointed to the improvement of flotation machines by greater simplification.

Vignettes of Geology

Simple interpretations of some complicated geological formations

(First part of a series)

John Carter Anderson

GEOLOGY applied to mining is of the utmost importance to all interested in mining. One may, on occasion, question the worth of the geologist, for when two or three geologists are met together in the name of geology they are likely to disagree, for geology is not yet an exact science. But none can deny that a correct understanding of geology of any property will pay for itself many times over in the direction of expenditures to develop and operate it, or by saving unwise expenditure on valueless property.

But, what is a correct understanding of the geology of a property, how do we arrive at it, and when do we know it is correct?

The geologist is, in a sense, always trying to answer an unanswerable problem. Nothing but the expenditure of money will answer it, and meantime geologists may disagree. How often we see money expended and lost when the answer was there to be read, could have been read, and may have been read and disregarded, because one who could not read disagreed with one who could, and the former, by telling his client what he wanted to hear—"certainly, this will make a mine"—carried the most weight. Illustrations of this will come instantly to the mind of every reader.

Years of field work have convinced me that the story is written in the rocks, and that "It can be read, if you can read it." But it must be read correctly to be of value.

Often the story is complex, and the geologist inclines to say: "It might have happened this way, or, it might have happened that way." If, on the other hand, one takes a firm stand, one is criticised as ignorant, biased, or too sold on his own theories of ore deposition. Yes, it might have happened this way, or, it might have happened that way. Actually, in each case, it happened but one way, and it is only as we approximate a correct understanding of how it did happen, that our work is valuable.

"It can be read, if you can read it." All of us have heard it said of some old miner: "He had a nose for ore." Perhaps he could neither read nor write, perhaps he could only talk in words of one syllable, perhaps he could not make his knowledge clear to anyone else. But he could read the field relationships of rocks, as affecting an orebody, and he knew that when he found certain rocks in a certain relationship with other rocks, or with certain structures within those rocks, and followed them, they led him to ore.

But the geologist, having read the story, must also be able to show it to his client convincingly. As the study of ore deposits has developed, multitudinous words have been coined to try to convey the picture from geologist to geologist. Until geologic terminology has become meaningless to any but the geologist. "Hypogene epigenetic," "crystalloblastic," "leptothermol," "authigenic," "pyrometasomatic." Just as a man lost in the woods, "cannot see the forest for the trees," so, none but the student can see the picture for the words.

In the study of an ore deposit one must first get the picture of its origin, what controlled and localized deposition, and at what horizon in the original deposit it has been exposed by "the accident of erosion," before he can form an intelligent estimate of its possibilities and how to prove them. This he must, in turn, make understandable to his client. Some men are so obsessed with details that they miss the picture. Others obscure the picture with so many, to their client, meaningless words, that, though he may be impressed with their great knowledge, he gets little understanding of what he has or what to do with it.

One who would pass judgment on a mine must be able to read the story that is written there for him, who can, to read. He must have a God-given faculty to be able to do so. Given this he can educate it. Without it no education can give it to him. He must follow one clue, then another; now on the property itself, more often far afield; for the answer is seldom to be found wholly on the property itself. One day he will get all answers. The next he will upset them all. He must not try to hasten a conclusion, but only to see facts. When he has seen facts enough, they will bring their own answer; and on that answer he can stand with assurance. Then he must reduce that answer to its simplest terms, so that his client can see the picture and understand the conclusions it forced. Just as the final solution of the most perplexing murder mystery falls into a simple pattern in the last chapter, so, as a rule, the final answer in the study of a mine may be reduced to a simple, direct picture that carries conviction to the one for whom it is made.

In trying to clarify his own thinking, then to make his conclusions clear to his hearer, I have developed a series of simplified word pictures of ore deposition, with which I have had much success in the field. They will be attacked by some as oversimplified. Some will disagree with my conclusions as to genesis. But they have stood the test in a wide and varied experience in the study of mines, have met with understanding by many who have accompanied me on the ground, and will be presented without apology in a series of thumb-nail sketches to follow this, in the hope that to some they may clarify the picture of why and how and when an ore deposit may be or become a mine, and, equally important, when to leave it alone.

"It can be read, if you can read it." If you can read it. It can be reduced to simple terms.

Whence Came the Ore and How?

Many men of many minds have long disputed the question of the origin of ore deposits. They still dispute and coin new words to convey their concepts. Most geologists today agree to an igneous origin of a majority of ore deposits, but differ as to modes and manners. Some agree to an igneous source of mineralization in some cases, but will not admit it in others, their minds refusing to reason back to a source with which they may not be able to see a direct connection exposed in the mine, or to accept as evidence

other outcrops in the area where "the accident of erosion" may have exposed the transition zone between that opened in the mine in question and the deeper zones that workings therein may not have discovered yet.

It is my belief that often more is to be learned about ore deposition from the transition zones seen in the properties that are not mines, in the economic sense, than from the producing mine.

Basically the ideas current today are not so far apart, but, as in religion, all talk about the same thing in different words, and not understanding each other, they disagree.

To the average man, vitally interested though he may be in learning the truth about a mine, a discussion of the genesis of ore deposits is all a headache, because it does not give him a picture his mind can grasp.

Believing it the duty of the engineer to show his client why he arrived at the conclusions given in his report, I have tried to present fundamental geologic principles in terms that, being related to his normal experiences, will convey understanding.

In presenting some of these, as a preface, I will state as a cardinal article of faith, that it is my belief that every primary ore deposit, not a redeposition or detrital deposit, has somewhere a connection with an igneous source.

For the first picture we will start with a question: "If a keg of hard cider freezes, what will happen?"

Usually the answer comes back, "The alcohol and water will separate." Correct. But that is not all. Hard cider is a solution of water, alcohol, and minor impurities that give flavor and odor. As it cools, because of different critical temperatures of crystallization, the water freezes first, causing the alcohol to retreat and segregate, carrying with it in more and more concentrated form those minor impurities that give flavor and odor. Ultimately we will have a core of still fluid alcohol and impurities within a keg of ice. If, then, we should drill a hole through the keg and the crust of ice, we would have a vein of alcohol with a concentration of the impurities rising through and perhaps freezing within the crust and the keg.

Just so, in the origin of an ore deposit. From time to time a hot spot develops under the crust of the earth. Why or how we will not attempt to say, except that these hot spots are local with respect to the crust of the earth as a whole, though they may be hundreds, even thousands, of miles in extent. Also, they may be repeated locally from age to age. Each may be considered by itself as a keg of hard cider, in which, as minor impurities, there is a widespread diffusion of the metallic elements. In one there may be an excess of iron, in another of zinc, in another of copper, but in each some traces of many of the common metals.

Clarke[1] says: "So far as we can determine, then, the magma, previous to eruption, is a mass of rock-forming matter, in a state of fusion, and heavily charged with gases under enormous pressure." "From a physiochemical point of view, a molten rock is to be regarded as a solution, behaving in all essential particulars exactly like any other solution. One or more minerals are dissolved in another, as salt dissolves in water; or, better, they are mutually dissolved, like a mixture of water and alcohol."

As this molten rock mass wells up into the overlying crust of the earth, it cools, and as it cools certain rock-forming minerals reach their critical conditions of formation, and, so, crystallize and lock together, forming a new crust, and forcing those minerals that are still fluid to retreat and segregate, carrying with them in more and more concentrated form those metallic ore-forming materials that were originally diffused throughout the molten mass.

When an avenue of escape is offered, by a fracturing of the crust, or otherwise, these more concentrated ore-forming solutions are drawn off and further segregated to form ore deposits. The longer crystallization continues within the magma before it is fractured to permit of the escape of the mineral-bearing segregations, the larger the resulting ore deposit may be expected to be.

And, so, from a diffuse solution, at high temperature, in which very small amounts of gold, silver, lead, zinc, copper, etc., could have been found, by this process of differential crystallization, whether the control be critical temperatures of crystallization, relative proportions within the mixture, relative solubilities, eutectic mixtures, or what not, everything still fluid under the conditions which cause the magma to harden into rock must segregate and concentrate and eventually be deposited in a more or less localized form.

[1] Frank Wigglesworth Clarke: "The Data of Geochemistry," U.S.G.S. Bull. 616, p. 298.

The type of the resulting orebody will vary according to conditions existing within the magma, the physical nature of the channel of escape, the chemical reactions between the ore-bearing emanations and the wall rocks and ground waters. But the source of the solutions in the molten magma is clear.

Genetic Relationships

The Philosopher says, "As on one plane, so on all."

Applying this dictum, much may be learned by thinking of geological processes in terms of life. A very clear picture of genetic relationship affecting an orebody may be given, I believe, by relating these to the facts in physical life with which all are familiar.

"Male and female created he them." Can we find a parallel in the study of ore deposits? I believe so.

We know that in physical life there must be male and female, a connection between the two, and a passage from the body of the male to the body of the female to conceive young. Just so in geology.

In the preceding section we saw that the ultimate source of the ores was in a localized molten rock mass, or magma, underlying the crust of the earth. This we will consider as the male parent, within whose body the ore-forming materials were segregated ready to be injected into the receptive formation.

The existing crust, whatever it may have been, whether sedimentary, igneous, metamorphic, or a cooled crust of the magma itself, was the receptive, or female parent.

The dike, sill, or other entry of the magma into the crust was the connection between male and female. If this intrusion penetrated or contacted a receptive formation and was followed by pregnant solutions, an orebody was formed.

It follows, then, that the presence of a primary orebody, not a redeposition or detrital deposit, argues a connection with an igneous intrusive. This may not be exposed anywhere that the vein is opened; as often happens, particularly in gold quartz mines. In these the vein often tends to so diminish in size, decrease in value, or change in character as it approaches the dike with which it came, that work is stopped before the like is contacted. And so, the presence of such a dike may not be suspected, or the possibility of its presence may be denied.

It is my belief that just as surely as when we see female give birth to young, we know that there has been a connection with a male, we may know when we see a primary orebody that, though perhaps unseen, it has somewhere a connection with an igneous source. There has been, I believe, no virgin birth in the genesis of an orebody.

Just as in physical life there can be connection without conception, so, in nature, dikes and sills of igneous rock may and do invade the older crust repeatedly without forming an orebody. In every major area of igneous invasion there tends to be a series of intrusives: "pre-mineral," "mineralizing," and "post-mineral," using the term "mineralizing" in the sense of being that intrusion which is most closely associated with the introduction of the ore.

Offshoots

This question of the sequence of offshoots from a cooling magma is of itself of great interest and great significance in a study of the segregations that take place within the magma. But suffice it to say here that there may be an acid, then a basic, "pre-mineral" outbreak from the magma, this series being sometimes twice and possibly three times repeated, without any evidence of accompanying mineralization. The absence of mineralization with these pre-mineral dikes may be apparent rather than real, however, in that it is possible that some of them were associated with mineralization that deposited in higher horizons, now wholly removed by erosion. But, as now exposed, they are definitely pre-mineral relative to the existing ore deposits, and this is the relationship that must be established for guidance in the study of the deposit under consideration.

Then there were one or more dikes, sills, or other type of intrusive, usually the most acid fraction of the magma, which were closely associated with the introduction of the ore. During this period the orebodies were formed.

These dikes may often be distinguished by the fact that they have pyrite, or other metallic sulphide, as a primary mineral, crystallized within the body of the rock, not just in seams or cracks.

The period of mineralization may have been followed by one of "post-mineral" intrusion, often in the series acid and basic, sometimes repeated. Often a post-mineral diabase, basalt, or other similar basic dike marks the dying gasp of the magma. The earlier dikes tend to follow the same general strike as the veins, so that they are found in or parallel to the veins, but this last basic dike more often cuts irregularly through the area, faulting the vein. Such basic dikes, faulting the ore and without genetic significance, are frequently seen in the large copper deposits. They are, I believe, a positive proof of an underlying, though possibly unseen, granitic magma. Once recognized as such they may throw new light on genetic relationships.

In every district it is necessary to determine the true place in the series of each dike and to discover that one which was associated with the introduction of the ore. Once this relationship is determined in any mine, or in any district, a criterion has been established that will be of direct guidance in all further study in the area. Just how this criterion applies will vary in each case according to the other factors which govern the deposition of the ore. In ore deposits of one type the discovery of a dike of this series may spell the end of commercial possibilities; in another, the beginning. But always the genetic significance is clear, if you are able to read it.

A misreading of these dike relationships has been, I believe, the basis of most objections to an igneous source of mineralization. Because, in a particular mine, a dike is found cutting an orebody in such a way that obviously it had no influence on the ore, it is taken as proof that there is there no connection between an igneous rock and the ore. For example, Nason took the post-mineral camptonite dike crossing the orebody at Franklin Furnace, N. J., as proof that there was never any connection between an igneous rock and an orebody. Yet he failed to recognize the earlier, altered intrusive sill which was directly responsible for the formation of the deposit.

Dikes

Returning to our analogy again: In physical life, when we see husband and wife living together and the wife give birth to a child, we assume that the husband was the father. That does not necessarily follow. So, in the study of ore deposits we often see an orebody lying in or adjacent to an intrusive igneous rock in apparent genetic relationship thereto, and base our reasoning on that assumed relationship.

This, I believe, has been the cause of many errors in geologic study. Oftentimes the earlier intrusion simply prepared the way for the mineralizing solutions that came with a later intrusion following the contact of an earlier as a line of weakness, without reaching as high in the formation as the horizon disclosed in the mine, nor giving evidence of its presence save in the ore that deposited in or on the contact of the earlier dike. Not seeing the later dike, we may ascribe the mineralization to the earlier, or we may use the conditions seen as an illustration that here there was no connection between the intrusive and the ore.

This finding of ore in, or in contact with, a basic dike, where the "mineralizing" acid dike has not yet been discovered, is the explanation, I believe, of the assumed relationship of ore deposits of certain types with basic, rather than acid, intrusives. I believe, also that a re-examination of the relationship between orebodies and serpentine dikes, which are popularly supposed in a number of districts to be genetically connected, would show that this association is accidental rather than genetic, and that both the origin of the veins and the serpentinization of the original basic dikes are directly related to a later acid intrusive.

A true understanding of these genetic relationships is of the utmost importance in the study of a mine. First, know your rocks, so that you can recognize each as an individual regardless of how many different phases it may assume. Second, know the relationship of each to the other. Then know the relationship of one or the other to the ore.

Zoning

We have discussed the way in which the metals, originally widely diffused throughout the body of a molten magma, are first segregated, together with quartz and other still fluid residues, from the rock-forming minerals as they freeze to form a crust, because of the differences in critical temperatures of crystallization. Also the way in which these metal-bearing segregations are injected into receptive rocks to form ore deposits.

These processes of segregation continue. From the moment the mineral-bearing solutions start to move from their source they are subject to progressively declining temperatures and pressures, which bring first one mineral, then another, to those critical conditions that cause them to form and drop out of the solution. Thus there is a tendency to a primary zoning whereby the bulk of the ores of one metal deposit above and beyond those of another, and so on, until all are deposited.

All metals were not present in all magmas; and those present varied widely in their proportions. Nor were all concentrated, necessarily, into one solution reservoir before an avenue of escape developed. Just as the rock-forming minerals tend to segregate to form the light (acid) and dark (basic) rocks that are successively extruded from a cooling magma, so it is probable that there is some measure of separation of the fluid residues within the magma. Certainly there was a wide difference in the resulting metal-bearing solutions. In one district gold may have been in excess. In another copper, or lead, or zinc. In one, the

less common minerals such as tin, tungsten, antimony, etc., may have been absent; in another, they were in sufficient concentration to form valuable deposits.

In each case, however, those metals present tended to deposit in distinct, though often overlapping, zones.

As the mineral-bearing solutions traveled they were further modified by water, by the temperature of the invaded rocks, and by other extraneous conditions. Hence every deposit does not show the same zones, with each metal above the other in orderly succession, like the steps of a stairway. But, wherever a primary orebody exists in which two or more metals deposited, the bulk of the ores of one metal will be found above or beyond those of another in a recognizable order.

Elaborate systems of zoning have been presented, the reconstructed vein ranging from mercury above to tin below, with barren zones above, in between, and below.

These have been based in part on changes observable in individual deposits as depth increases; in part on the changes observed in a single deposit, or in groups of deposits, at increasing distances from an intrusive igneous mass, or batholith, with which all are presumed to be related in origin; in part on the presence or absence of certain high-temperature gangue minerals.

Those changes observable in a single deposit, either vertically or laterally, are, I believe, the better guide. A regional change may be more apparent than real, as it may not be recognized that a given deposit, though farther from the surface exposure of the parent intrusive, may have a much closer connection with its parent than another type of vein lying between it and the exposed batholith. In my observation, the mass contact of the intrusive is usually barren, or relatively so. Valuable mineral deposits seem to have been concentrated first in a solution reservoir within the body of the magma, below the forming crust, and then to have been injected into and above that crust in association with later offshoots of the still molten magma. Where one of these offshoots reached high into the overlying formations, it may have carried deep-seated types of ore deposits much higher than deeply buried offshoots lying between it and the main exposure of the batholith.

This is the true relationship between the Foothill copper belt of California, the Mother Lode gold veins, and the Sierra Nevada batholith, which have been mistakenly used as an illustration "That gold ores lie nearer the intrusives and copper ores farther away[2]."

In fact, the ore in the Calaveras Copper mine, the largest of the Foothill coppers, is directly related to a massive, mineralized dike, such as may be expected to be found eventually below the Mother Lode gold veins. It is notable, furthermore, that gold is almost nonexistent in the Calaveras copper ores.

In the study of every deposit, distance from the magma, from whence it came, is of real importance, and, broadly speaking, the greater the distance from it that ore is found, the better the chance for extension in depth. But this distance must be real, not apparent. One must first determine the main channel through which the solutions moved, in the individual deposit, and its relationship to the parent magma, or the offshoots therefrom that localized the deposition of the ore.

Once this main channel is determined, the resulting zoning must be related to it as well as to the source. When dealing with the more common metals, the normal sequence of deposition is that the bulk of the zinc will be above, or beyond, the bulk of the copper; the bulk of the lead above the zinc; the bulk of the silver above the lead; and the bulk of the gold above the silver. Antimony and mercury deposit with and above gold, and copper mines in some localities have turned into tin mines with depth. There may be a greater or less overlapping of the zones, to form complex ores, and metals of the deeper zones may be found in gold veins, and may even be accompanied by an increased deposition of gold. For instance, a little scattered galena in a gold quartz vein may locally increase its tenor, and from such a vein the galena concentrates will be much higher in grade than the normal pyritic concentrate. But in the same vein, a relatively large bunch of galena concentrates will be much higher in grade than the normal pyritic concentrate. But in the same vein, a relatively large bunch of galena will carry much less gold than the average of the vein. The same is also often true of the association of pyrite and gold in a gold quartz vein.

All veins do not have all zones, nor in equal proportions, and in any deposit any of the zones may, economically, give way to a barren zone above or below. But, always, I believe, there is a tendency to a primary zoning of those minerals present; in some the graduation is very delicate. A recognition of those zones present, or to be expected, may be of great commercial importance.

Pyrite has a wide range of travel, appearing in veins formed at all but the greatest depth. It was formerly thought to mark the bottom of a copper deposit, especially those low-grade copper deposits that were brought to a commercial grade by processes of secondary enrichment; but copper sulphides may form at higher temperatures, hence deeper, than pyrite. In very high-temperature deposits, iron is deposited as a primary oxide, rather than as a sulphide. Yet in many deposits copper sulphides are intimately associated with these primary iron oxides. The Engels copper mine is a notable illustration of this association. It is of interest that the deepest-seated minerals, such as the tin ore, cassiterite, and the tungsten ores, are primary oxides, or combinations of oxides, as are most of the rock-forming minerals.

In 1923 I wrote[3]: "There is a strong presumption that the low-grade cupriferous pyrite, from which large bodies of commercial ore have been built up by processes of secondary enrichment, does not represent the bottom of commercial mineralization, but lies above the zone of maximum deposition of the primary sulphides of copper."

There has been ample proof of this since, as in the development of the La Colorado orebody at the Greene Cananea Copper Co., to warrant the belief that this is a zoning principle that will have increasing economic application.

Zoning did take place in the primary deposition of ores, and a knowledge of the changes to be expected in depth is essential to a sound understanding of the possibilities for development in a given mine, or under a given outcrop. "The accident of erosion" exposed each deposit at a different point, and one must have some understanding of the changes that took place during deposition, before he can wisely predict the future of the deposit.

(To be continued)

[2] W. H. Emmons: "Ore Deposits of the Western States," p. 348. 1933.

[3] John Carter Anderson: "Economic Application of Zonal Theory of Primary Deposition of Ores." *Trans.* A.I.M.E. Vol. 69, p. 25, 1923.

Dredging Alluvial Tin in Bolivia

Huanuni placer deposits, 20 to 50 ft. deep, are jigged on the dredge and the crude concentrate is finished in a mill by the usual gravity separation methods

Robert D. Ferron

Manager, Bolivian International Mining Corp., Huanuni, Bolivia

Huanuni dredge of Bolivian International Mining Corporation. Concentrating mill and camp in right background

Concentrating mill where crude jig concentrates from dredge are finished

THE TIN DREDGE of the Bolivian International Mining Corp., near Huanuni, Bolivia, is the only dredge that has operated in Bolivia in many years. The company frequently receives inquiries as to operating data from persons considering dredging projects in southern South America. The present importance of tin as a strategic war metal, and the high price of this metal, have caused an increased interest in Bolivian tin dredging. For these reasons, a brief description of the Huanuni dredging operations will be of marked and timely interest.

The placer deposits worked by the dredge are contained in the valley of the Huanuni River, just below the town of Huanuni, at a distance of 50 kilometers to the southeast of the mining center of Oruro. The upper river deposit lies just below the high hills on which are situated the tin veins and mine workings of the Huanuni property of Patiño's Bolivian Tin & Tungsten Corp. These vein deposits constituted the origin of the placer deposits, tin ore having been eroded from the outcropping veins in past geologic epochs, and concentrated in the valley below. The river placers seem to have been formed by a combination of glacial and river action.

Scattered residual deposits are still found on both slopes of the Huanuni Valley, high above the present valley floor, and for a distance of 10 kilometers below the Huanuni mines. The river swings around the Huanuni Mountain, which fact has allowed the lower river placers to be laterally enriched by short feeder streams heading near the high tin vein deposits.

The gravels in the Huanuni River bed vary from 20 to 50 ft. deep. Large boulders are infrequent. Dirt overburden varies from nothing to 15 ft. in depth. Clay is often present in sufficient quantity to slow down dredging work.

Water is scarce. The tin ore deposit varies from particles of minus 300-mesh size up to chunks 2 ft. in diameter. Pure cassiterite particles are rare, practically all of the tin ore occurring as rounded particles of vein matter containing cassiterite, quartz, oxide iron minerals, and wall rock. These may assay anywhere from 1 to 30 percent Sn, and require grinding to free the cassiterite. Bedrock is soft shale. From 3 in. to 12 in. of bedrock are dug, as the best tin is often found on and mixed with the upper bedrock. At times higher tin-bearing strata are found in the placer gravels, separated from the bedrock by barren gravel. These usually represent lateral enrichments of later date.

Drilling was started on the property in 1927, using 4-in. Empire drills. After sufficient yardage had been developed, the present dredge and mill were constructed, and operations begun in 1930. In the intervening ten years of operation 15,000,000 cu.yd. of placer have been dredged, and about 5,800 tons of fine tin recovered in the form of a concentrate assaying over 60 percent Sn. Average recovery of all ground dredged has been 0.85 lb. of fine tin per cubic yard. Richest ground was found in the upper part of the deposit. The placer has become progressively leaner as the dredge has moved downstream, away from Huanuni Hill, the original source of supply of the tin ore.

Dredge and mill recovery have always been lower than drilling results. The reason for this is that the only

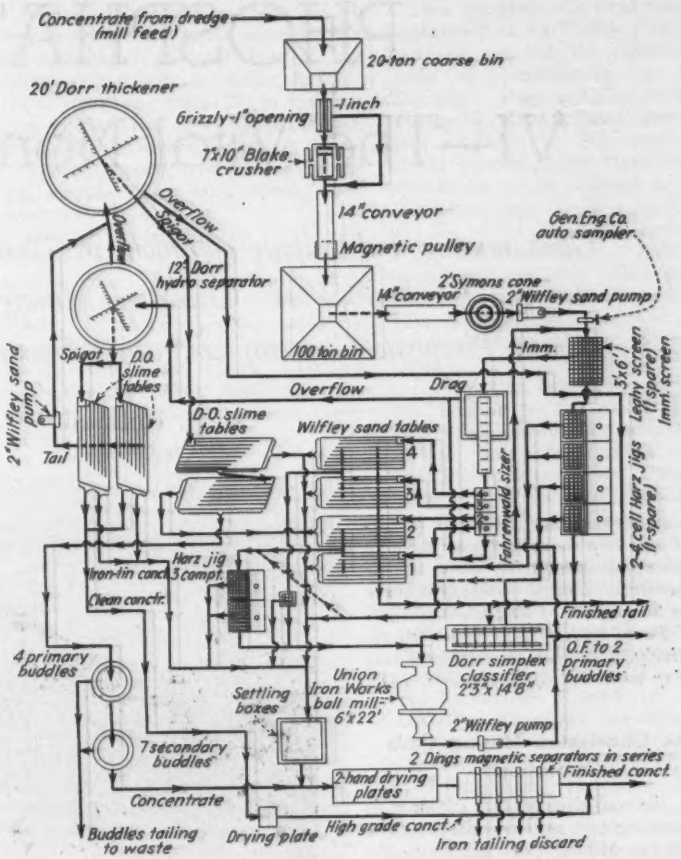
practical procedure for drilling calculations is to base results on the assay value of a low-grade tin concentrate panned from drill-hole sludge. In practice, the dredge does not recover light middling particles and fines to the same extent as can be recovered by a good panner. Experience is therefore essential for proper interpretation of drilling data. The property still contains dredging ground sufficient for many years of operation.

Crude Concentrate from Dredge

The dredge machinery was supplied by the New York Engineering Co., the Yuba Manufacturing Co., and other manufacturing concerns. The digging ladder is equipped with 67 Amsco 9½-cu.-ft. buckets, with bolted lips. The dredge is capable of digging 38 ft. below pond level, and has carried banks up to 20 ft. high. Its revolving screen is 7 ft. in diameter. The upper screen is equipped with cast manganese steel plates containing perforations varying from ¾ x 1 in. to 1¾ x 2¾ in. The undersize products from this portion of the screen flow to seven three-cell Cooley-type jigs. Jig bedding is formed automatically by coarse tin particles in the feed, the excess as it builds up on the jig screen being periodically shoveled off to the floating bins. Jig tailings are run to waste in the pond. The hutch product from the primary jigs is sent by elevator to a three-cell cleaner jig. The hutch product and excess bedding of the cleaner jig are sent to the floating bin; the tailings go to waste. The lower end of the screen is equipped with two short sections perforated with holes 2½x4 in. and 10x12 in. respectively. Material passing these two sizes drops to two stacker belts; larger boulders drop to the pond. Five sorters on each stacker belt carefully pick out all possible coarse ore, which is also sent to the floating bins. Finally, the bins receive concentrate from a Pan American diaphragm jig treating the save-all material. The crude concentrate in the floating bins varies in size from slimes to pieces 2 ft. in diameter. It assays from 4 to 20 percent Sn, depending chiefly on the proportion of iron minerals to tin minerals in the ground dredged. Every effort is made to recover all products that indicate any tin content.

Dredge Concentrates Cleaned in Mill

A light railway line from the mill is carried forward as the dredge advances. The floating bins are pulled ashore when filled, and their contents loaded into cars by a portable conveyor. The cars are hauled to the mill by a gasoline locomotive. As the mill treats a product corresponding to mine vein matter, it is a typical Bolivian tin mill, employing the usual gravity separation methods, as indicated on the flowsheet. For the reason that no sulphides are contained in the material treated, and because the chief heavy impurity is a variety of oxide iron minerals, cleaning of the concentrates is done by magnetic separators, two in series as rougher and cleaner. Principal losses of tin are in the slimes, as is usual in gravity concentration. Every effort is made, therefore, to grind only fine enough to free the tin particles, and to avoid sending to the ball mill any tin particles that are already free and in condition to be separated from iron and gangue minerals. The mill has a capacity of 60 tons per 24 hours, and is operated one or two shifts of 8 hr. each, according to the amount of dredge concentrates produced. The mill feed being a rough concentrate, a mill recovery of around 90 percent can usually be made.



Flowsheet of the B. I. M. C. concentrator

The staff consists of four foreigners only, the dredge and mill being operated entirely by Bolivian labor. Including hand-sorters, shore crews, and dredge operators, the dredge employs 90 men per day, or 30 men per shift. In addition, 60 to 70 men are employed in the mill, shops, and as watchmen.

Electric power has been purchased, costing 2.5c. U.S.Cy. per kilowatt-hour. The dredge has 506 hp. of installed motors, and the mill and shops have 280 hp. of installed motors.

Operating and cost figures given herewith are the average, when the dredge was running twelve months of every year.

Some Operating Data.	
Hours operated, average per month	603
Percent total days operated	90
Cubic yards dredged—Average per month	186,300
Cubic yards dredged—Per operating hour	308

Average Operating Costs per Cubic Yard Dredged (I).	U.S.Cy.
Operating salaries and labor	$0.019
Power Cost	0.037
Repairs and supplies	0.022
General and overhead, legal reserves etc.	0.038
Total	$0.116

Average Operating Costs per Cubic Yard Dredged (II).	U.S.Cy.
Total dredge operating costs	$0.082
Total milling and hauling costs	0.034
Total	$0.116

PHOSPHATE

VI—The Vital Non-Metallic

Other mining and washing operations in Tennessee, including those of Armour Fertilizer Works, Charleston Mining Company, Hoover & Mason Phosphate Company, and the Monsanto Chemical Company

A. H. Hubbell
Associate Editor

▶ THIS INSTALLMENT *completes the account of a trip made last year through the phosphate-producing areas of the southeastern United States, whence comes 95 percent of this country's output. Parts I to V were published respectively in the five consecutive issues starting with that of September, 1940.*

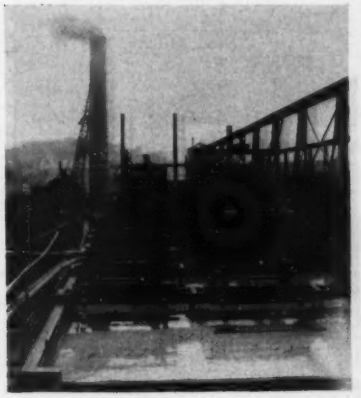
The Charleston Mining Co.'s Operations

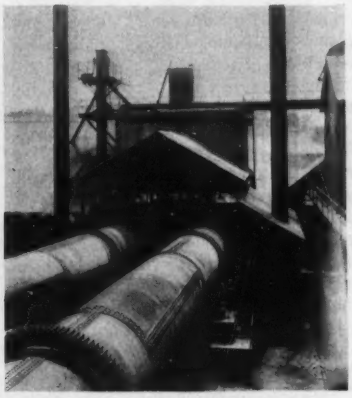
On the outskirts of Mt. Pleasant is the washing and recovery plant of the Charleston Mining Co. Thanks to the kindly tolerance of R. J. Grissom, superintendent, in the absence of the division manager, W. S. Stringham, I was privileged to visit it on a Sunday morning. At this time the company was engaged in building a new and larger washer around the old one without interrupting the operations.

This company employs about 350 men. Three shifts are worked where necessary. The mines are operated on one 8-hr. shift, although stripping is sometimes done on night shift. Mines and the washer (known as the Arrow plant) run six days per week, the washer working three 8-hr. shifts. The work is arranged to give 40 hr. per week per man.

Several pits are operated, the average haul, by rail, to the washer being 3½ miles. Transport is effected in trains of 4-cu.yd. Western side-dump cars hauled by steam locomotives. Some matrix is handled also by contractor's trucks. The procedure may be varied from pit to pit. As an example, cited by Mr. Grissom, they may load cars on 36-in. gage track of 40-lb. rails and gather from the various pit areas, with 21-ton steam locomotives, to some central point in respect to the pits and from there haul in trains on 60 to 70-lb. steel of the same gage to the plant.

The draglines, eight in number, at the pits vary in make, type, and drive.





Left, Some of the large dewatering drags at the Charleston Mining Company's washer. At the sides beyond them for handling washed products are respectively a steam-driven crane with a clamshell bucket and a traveling crane. In the distance is the nodulizing plant. Right, a closer view of the nodulizing plant and its two 8x110-ft. rotary coal-fired furnaces

To show this variety they are listed as follows:

1 new. Model 38A Marion, Hesselman semi-diesel drive, caterpillar-mounted

2 Model 50B Bucyrus, steam, caterpillar-mounted

1 Model 150B Bucyrus, steam, mounted on four trucks

1 Model 24 Bucyrus, steam, skid and rollers

1 P. & H., gasoline, caterpillar-mounted

1 Model 40 Lorain, diesel drive, caterpillar-mounted

1 Model 14 Bucyrus, steam, skid and rollers

These units have booms ranging from 40 ft., with a ¾-cu.yd. bucket, to 115 ft. in length with a 3½-cu.yd. bucket. The bucket must not be too large to fill a 4-cu.yd. car.

The old-type excavators are gradually being replaced with modern units. According to Mr. Grissom, there is a limit on the caterpillar-mounted machine in the Mt. Pleasant area. For draglines having booms longer than 80 to 90 ft., and buckets larger than 2½-cu.yd., he thinks the walking type is better, in view of the undulating terrain and the possibility of getting into hillside work. Moreover, where the matrix is irregular, as where there are cutters, the percent of loading time is cut. Thus smaller machines have their advantages. There is also a place for a wide range in size of buckets.

In stripping, the capacity of the older machines will vary from 600 cu.yd. to 1,200 cu.yd. in 8 hr. The new Marion is expected to move 160 cu.yd. per hour. When matrix is dug with stripping, however, yardage can be estimated only with difficulty.

A drying plant and a nodulizing plant lie on either side of the wet storage yard, which is in its natural position at the end of the washing plant. Nodules are being made for another company for reduction in the electric furnace, specifications calling for nothing larger than 2½ in. nor smaller than 10 mesh. The feed is a washed product. The nodulizing is done at 2,200 deg. F. in two 8x110-ft. rotary furnaces, countercurrent and fed with pulverized Kentucky slack of 1,100 to 1,200 B.t.u.'s. For drying

sand there are four counter-fed furnames, two of them hand-fired and two with Detroit stokers, using Kentucky slack. They dry from approximately 18 percent moisture down to 1 percent.

Higher-grade matrix is, in general, becoming scarcer, and in any case an operator naturally desires to make the most of his resources and to use his lower-grade materials. To do this profitably means handling larger tonnages, and with a company such as the Charleston, which makes a practice of using a great deal of water in washing phosphate, this means a provision of larger settling areas. This will explain, according to Mr. Grissom, the extensive use of the large Esperanza-type drags, hydro-classifiers and large thickeners.

Modernizing has also been under way in other ways in the district. For example, only recently one of the operators had been unloading its matrix at its washer from 20-ton railroad cars with a crane. Now these cars are unloaded over a washing pit by means of hydraulic guns. One company is using electric drags and diesel truck haulage.

Electric power is cheap in the Mt. Pleasant area (a T.V.A. power line crosses the Charleston property). There is a half-mill rate for large blocks. In view of this one should not be surprised to see more electric units in the field, even electric main-line haulage. As labor costs increase, electric power should become more attractive.

Part of the washing plant of Charleston Mining Company. At the time this picture was taken, alterations were under way for the purpose of increasing the plant's capacity

The trend toward larger-scale operation in the district is noticeable. Mr. Grissom pointed out that, whereas six or seven years ago a bin larger than 25 tons at the head of a plant was a rarity, today the Charleston company was providing for 2,500 tons and in addition was storing unwashed rock in the open outside the plant, using a Sauerman tower-scraper system to pull the material in. In reconstructing its plant on a larger scale, one 800-ton concrete bin had already been built beneath the dumping trestle, and the hoist for a 2-cu.yd. scraper mounted over the feed end of the first piece of washing equipment—a large scrubber—next to the bin to scrape the rock from the bin into the scrubber. Just over the feed end there is a grizzly with 12-in. spacing, up which the scraper rides to dump into a box from which the scrubber feed scoop picks up the matrix. Also set up in the bin over the feed end are three hydraulic guns which sluice the matrix through the grizzly and provide water for scrubbing. Within the scrubber also high-pressure water helps to break up the mixture of clay, sand, and phosphate.

The Armour Fertilizer Works Near Columbia

The Armour Fertilizer Works have their phosphate washing plant and dryer, as well as their district office, out in the field 7 miles west of Columbia. Calling upon them the following day, I was fortunate to meet W. B. King, the superintendent, and B. A. Mitchell, assistant superintendent, as well as Frank Dunbar, chemical engineer.

An informal snapshot of R. J. Grissom, superintendent of Charleston Mining Company

This company was producing phosphate only at its Ridley property, at Ashwood, and at its Peerless mine, south of Columbia on the Pulaski Highway. Some of the ground belonging to it near its plant has already been worked out. The matrix mined in the pits is hauled from the point of loading to the railroad in 3-cu.yd. side-dump cars on 36-in. gage track by 18- to 20-ton steam locomotives. From the trams it is transferred to 60-ton steel gondolas, with hopper bottoms, that are supplied by the Louisville & Nashville R.R., and in this manner transported to the washing plant.

Each of the two mines at the time was sending to the washer approximately ten 60-ton cars of matrix per 24 hr. Both were working one 8-hr. shift five days per week. The washer, however, was running three 8-hr. shifts five days per week. Half of the total force of 300 men was engaged in mining, washing, and drying, and the rest of the crew were employed in the fertilizer plant.

Stripping and mining were being done with draglines having booms ranging from 50 to 60 ft. in length and buckets of ¾-cu.yd. to 1¼-cu.yd. capacity. There are five diesel-driven machines at this property—namely one 50B Bucyrus, one K55 Link-Belt, one K45 Link-Belt, and one No. 700 P.&H. In addition there is one gasoline-driven Orton. These draglines are furnished with extensions whereby the boom of the machine may be lengthened 10 ft.

Water in the pits is handled by 2-in. to 3-in. gasoline-driven centrifugal pumps.

The Armour washing plant was built originally in 1918 but has been remodeled frequently since then. Only recently changes have been made. Today its capacity is rated at 225 tons per 10-hr. day. I went around the plant with Mr. Dunbar, with whose aid the approximate flowsheet shown in Fig. 16 was drawn. The chain drags shown were built by Armour locally. Their frequent use in the treatment is indicative of the work involved in separating the clay from the matrix. No close control of the percent of solids is attempted, so greatly does the matrix vary. At the time of this visit, flotation equipment consisting of one 3-cell Denver Sub-A machine, shown in the flowsheet, was being installed. Material that is intended to be delivered to wet storage for drying is handled by an electric bridge-type crane.

Drying is done with two 6x50 ft. rotary countercurrent furnaces, stoker-fired with coal screenings. These are fed from a hopper by a circular feed table. This plant, it was said, would dry 10 tons per hour per dryer to less than 1 percent moisture from 20 to 25 percent.

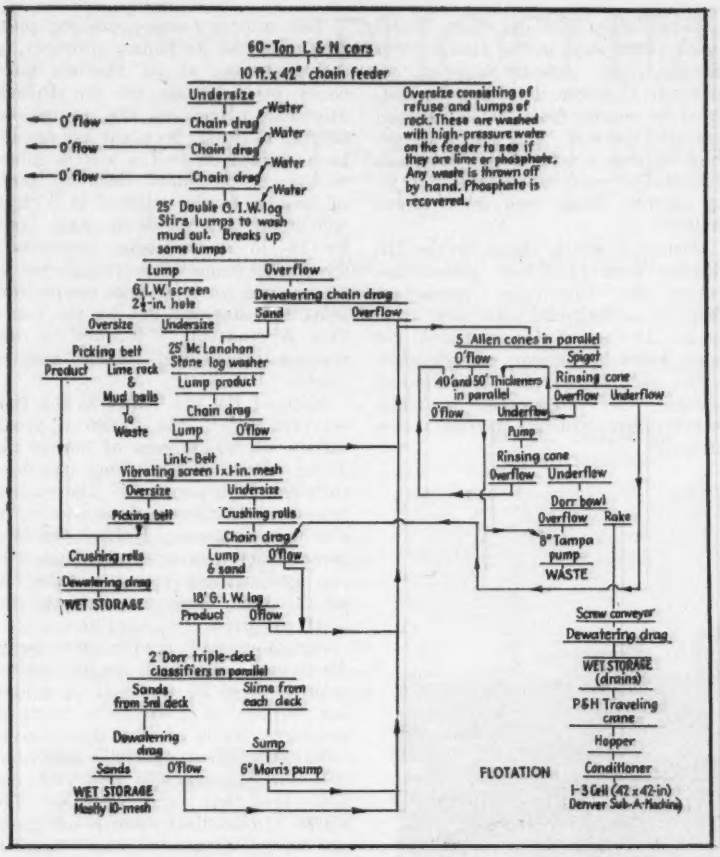


Fig. 16 . . . An approximate flowsheet of the phosphate washer and recovery plant of Armour Fertilizer Works in the Columbia district, Tennessee

The Hoover & Mason Co. Has Extensive Holdings

Mining in the Tennessee phosphate area is a selective job rather than one of producing tonnage, asserted R. S. Morrison, superintendent of the Hoover & Mason Phosphate Co. at Mt. Pleasant, as we set out the following day to go over several of the company's tracts. The ability of a dragline operator here is gaged, he said, not by yardage worked but by the amount of matrix he can load. How true this might be became evident as we went along. The tracts we saw varied greatly in depth of overburden and in the thickness of the matrix and in the ratio of the two, and the underlying limestone, where exposed by mining, exhibited the changes from smooth contours to the jagged walled cutters that so frequently lessen the efficiency of the mechanized operation and force resort to manual labor. In Tennessee, a much greater percent inevitably of the operating cost is labor than in Florida, where it has been possible to mechanize to such a high degree.

These deposits of the Mt. Pleasant district have come from the Bigby limestone, according to R. W. Smith, formerly of the Tennessee Division of Geology. Here the formation is richer in phosphate than elsewhere and occurs, he says, under topographic conditions ideal for forming blanket deposits. The average depth of overburden has been put at approximately 12 ft. [35] The Tennessee mines usually handle less overburden per ton of phosphate than do the pebble mines of Florida.[36] But the conditions are very different.

The Hoover & Mason company is one of the largest holders of phosphate lands in middle Tennessee, these holdings including both fees and mineral rights. Its operations are limited to mining, washing, drying, and grinding. It employs approximately 180 men. Its products are sold to fertilizer manufacturers, although some of its washed and ground raw rock is being disposed of to mid-Western farmers for application directly to the soil.

Only a small part of these holdings are under exploitation, as might be surmised. This portion comprises the Solita, Porter, and Kittrell tracts, the last famous for its productivity in the past and recently worked, though idle temporarily at the time. I visited the three with Mr. Morrison, and the trip, limited as it was, sufficed to show the nature of the company's mining operations and something of its problems.

[35] James A. Barr, testimony before Joint Congressional Committee to Investigate Phosphate Resources of the United States. 1938.

[36] "Phosphate Rock Mining," 1880–1937, U. S. Bureau of Mines.

R. S. Morrison, superintendent of Hoover & Mason Phosphate Company at Mt. Pleasant, Tenn.

These tracts are part of an unbroken strip of company-owned lands stretching 4½ miles up Quality Creek, near which the washing plant is situated, 3 miles outside Mt. Pleasant. Part of these lands are virgin; part have been mined, if not re-mined, before. The early miners looked for plate or lump rock and left the rest behind. Their successors sought plate that had been missed or tried the deeper portions. Today the fine material, or phosphate muck, is the principal objective of re-mining, together with such plate as may remain. Rarely the earlier miners kept their overburden separate from the muck they left behind; the result being that mining conditions in such places are poor.

Thus the Solita ground consists of a virgin tract, exploitation of which was then under way, and a previously mined area that was being reworked. In character the two portions are quite unlike. On the virgin ground a fairly even blanket deposit was being stripped and mined by a Model 3T Monighan steam dragline—a walking unit, with 70-ft. boom and 2½-cu.yd. bucket and handled by a two-man crew. Here the matrix-overburden ratio was said to be 12 to 1. The matrix was dark in color and low in grade, being high in silica and iron (this accounting for the color), and lay in a 3-ft. bed above the limestone. Immediately over it was a seam of dense clay, which had kept more impurities out, and at the contact some lump rock occurred, which helped make the deposit workable.

The ground had originally been prospected by test pits, 4x6 ft. in section and 100 ft. apart, with "rodding" to determine the distance to the line.

By such means the presence of cutters could be ascertained, according to Mr. Morrison, who added that in prospecting they get all available data and then cut the estimates 30 percent to make allowance for the limestone.

O. H. Wustrack, Hoover & Mason Phosphate Co.

The other Solita area had been worked by hand in 1906, at which time only the lump rock had been removed. Lime horses run through it and the weathered limestone of the old cutters is exposed. The principal cutters trend in a northwest-southeast direction, although smaller ones may run irregularly. Mining was being done in a series of parallel cuts, 60 ft. wide, with a Model 655-A P.&H. caterpillar-mounted diesel dragline having a 60-ft. boom and a 1½-cu.yd. bucket.

Here the matrix was being loaded into 4-cu.yd. side-dump cars which were hauled on a 36-in. gage track by 18-ton Davenport locomotives. A useful operating detail was noted. To bring the empties up-grade to the dragline as needed, a gasoline-driven winch was used. This was mounted on a car that was anchored to the track beyond the excavator.

On the Porter ground, two tracts were also visited. On No. 1, a virgin tract, the ratio of matrix to overburden was said to be 3 to 1, with 9 ft. of usable matrix carrying a large percentage of plate rock. Non-usable matrix was being loaded and stored separately. In this category falls anything that would wash up to 50 percent B.P.L. This tract was being worked by a Model 3T Bucyrus-Monighan walking dragline, driven by a 100-hp. Fairbanks-Morse semi-diesel engine. The machine had an 85-ft. boom and a 2½-cu.yd. bucket. The tract adjoins holdings of the Federal Chemical Co.

The Porter No. 2 has a matrix-overburden ratio at its west end of 5 to 1. At the east end the ratio is 1 to 1. It was idle.

South of the Solita ground lies the Kittrell tract. The high-grade material that gave it local fame is thought to be exhausted. Part of it is to be reworked, using ground slides, or sledges, with men who will handpick the scattered lump rock remaining. This entire area was overlain by a tough clay that had kept impurities out. In parts the matrix-overburden ratio was said to be 1 to 1 and better, and the recovery 60 to 80 percent, yielding a 75 percent rock. Some of the cutters are 20 ft. in depth.

The washing plant of Hoover & Mason is at Mt. Pleasant. Its capacity is approximately 40 tons of washed product per hour, dry basis, on an average, varying with the type of matrix. Its flowsheet is an unusual one, at least in respect to some of the equipment. It manifests two things already mentioned—the liberal use of water and frequent scrubbing for freeing the clay from the phosphate particles and the consequent need of large settling areas. The large volume of water that the Florida operator sends to the washer by the use of hydraulic methods at the mine the Tennessee operator supplies in other ways. Mr. Morrison holds that the Tennessee washer in general does excellent work. The Tennessee phosphate particles are porous, making it difficult to wash out the impurities of iron and alumina. He declares also that for various reasons the Tennessee operator has been able to spend less on replacements and modernization and that in consequence the trend in this direction has been slower.

The plant has two dewatering and desliming units, No. 1 and No. 2. Three sizes are separated at No. 1 unit —namely, +1 in.; −1 in. + 35 mesh; and − 35 mesh. The first and second of these sizes combined constitute approximately 70 percent of the total output. The −1 in. + 35 mesh material is removed and the − 35 mesh is overflowed at approximately 11 percent solids into No. 2 unit or into six 16-ft. Allen cones. The cones are used at the operator's option, which is governed by the nature of the deposit being mined and by the quantity of water available at the time of washing.

Two classifiers are used in the flowsheet. No. 1 is a Dorr Type LDSCB-20 unit, its dimensions being 5½x28 ft. with a 15-ft. diameter bowl. No. 2 is a No. 520 turret-type bowl classifier. Its dimensions are 33 ft. 4 in. by 8 ft., and the bowl is 20 ft. in diameter.

A hydroseparator is provided, the feed delivered to it usually being −35 mesh and approximately 10 percent solids. Hydroseparator underflow averages 15 percent solids and − 35 + 300 mesh.

Operations of washing, drying, and grinding are electrified completely. Power is purchased from the Tennessee Valley Authority and is stepped down by the company from 2,300 v. to 440 v. for use. The principal problem in the plant is the collection and handling of the 200-mesh sizes.

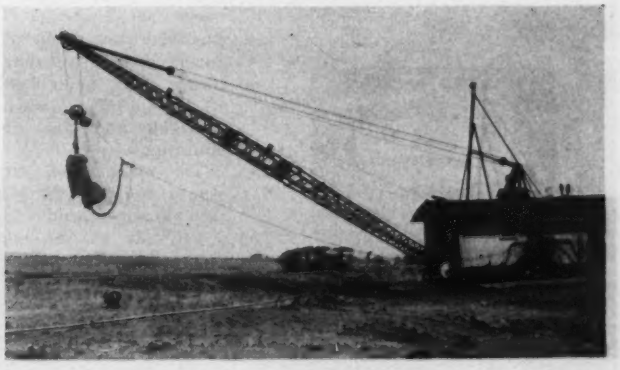
Three settling ponds are used. No. 1, for sludge settling and storage, covers ten acres. The washer was recovering sludge from it at the time. No. 2, of 40 acres, serves a similar purpose. No. 3, of 30 acres, is for storing fresh water.

Washed products, containing 34 percent of water, are drained and delivered to the 80-ton hopper of the drying plant. From this they are fed by belt to two parallel-flow rotary dryers, one 6x35 ft. and the other 7x30-ft. in size, fired by a stationary-grate, Detroit roto-stoker furnace burning 1½-in. screenings of No. 9 seam West Kentucky coal. A Clarage fan provides the draft.

Dried material is sized by screening and sent to storage via a 4½-ton skip hoist. In the 72x210-ft. stock shed four classifications are made, two for unground material and two for

Re-mining certain ground on the Solita tract with a caterpillar-mounted P. & H. diesel-driven dragline. It has a 60-ft. boom and a 1½-cu.-yd bucket. This portion of the tract was originally worked in 1906 by hand

On the virgin portion of the Solita ground. Here the stripping and mining were being done at the time of the visit by this steam-driven Monighan walking dragline, which also has a 60-ft. boom and a 1½-cu.yd. bucket



ground. A tunnel runs underneath, through which the rock can be reclaimed for bagging, loading cars, or grinding. The last is done in two five-roller high-side Raymond mills with 8½-in. rolls. Each takes a 75-hp. motor for the mill and a 40-hp. motor on the fan.

To house employees the company has more than 60 dwellings with separate villages for white and colored people. The rent charged is just sufficient to take care of the maintenance and the electric light. For the colored people a school house and a church are also provided. These communities are guarded by a fire-protection system.

Monsanto Chemical Produces Elemental Phosphorus

Conception of phosphate rock as the ore of phosphorus has proved intriguing ever since we first heard of the direct production of this element by electrothermal means. That the "miraculous light-bearer" of the alchemists could be so extracted, and in tank-car quantities, from the prosaic raw material has been a thought to dwell on. We dealt with it in the preface[27] of this travelogue, and now, in the closing chapter, find the idea uppermost again, for it remains to describe a visit—the last one of the trip—to the Monsanto Chemical Co.'s great enterprise in Tennessee, where phosphorus is being produced by the electric smelting of phosphate muck that is mined near by and washed and sintered as preliminaries to the furnace treatment. Not that we shall discuss the furnacing and subsequent condensing, for the privilege of entering that portion of the plant is extended to few. As it was, we were fortunate to see the other operations and under the guidance of Felix N. Williams, manager at Monsanto, who accompanied the party of three, including this writer and Messrs. Morrison and Wustrack, of the Hoover & Mason staff.

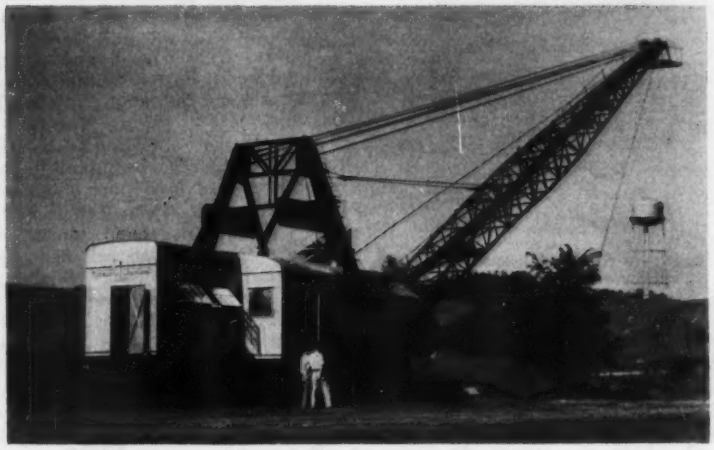
Monsanto's story, so far as phosphorus is concerned, begins at Anniston, Ala. Here the Federal Phosphorus Co., later known as the Swann Chemical Co., had pioneered as early as 1920 in the use of the electric furnace for making phosphoric acid from lump phosphate rock. Fifteen years later, in 1935, when Monsanto took control of Swann, it began research into the possibility of making phosphorus from phosphate rock on a large scale in the furnaces at Anniston and turned also to finding a plant site nearer to a supply rock. As a result it acquired 2,000 acres, later increased to 2,500, west of Columbia, in Tennessee, and late in 1936 had completed a sintering plant on its property, at a site that it named Monsanto, and was shipping its own matrix, sintered without washing, to its furnaces at Anniston. Meanwhile it pushed construction of three electric furnaces, in direct line with the sintering plant, the first going into service in June, 1937. A washer soon proved desirable and was erected ahead of sintering.

This enterprise, since completed, stands today at Monsanto, a monument to this organization's progressive spirit. It has no counterpart elsewhere in this country or abroad. Mining, washing, and sintering of phosphate muck, and the electrothermal production of elemental phosphorus, are all conducted within a short distance of each other.

The phosphate properties, which lie along the Duck River, surround the plant. On the Baird property to the north, where considerable mining has been done, some deep and narrow cutters that are said to have carried 45 ft. of phosphate have been uncovered, exposing the Bigby formation at this point. The Hermitage is also productive in this area.

At the time of this visit, mining was being done near the plant on what appeared to be fairly easy ground. The occurrence of the matrix is variable. A tract next to the one being worked, we were told, had little or nothing on it. The matrix-overburden ratio, it was also said, averaged here approximately 1 to 1.

Since the start, all stripping and most of the mining have been done with a Bucyrus-Monighan electric walking dragline, operating on 2,300 v. and having a 105-ft. boom and a 4-cu.-yd. bucket. A P.&H. clamshell excavator of 2-cu.-yd. capacity is provided for working the cutters that happen to be encountered if they are too narrow for the dragline bucket. At the time of an earlier visit made



All stripping and most of the mining of the phosphate muck done by Monsanto Chemical Company on its ground at Monsanto, Tenn., has been accomplished with this Bucyrus-Monighan electric walking dragline. The boom is 105 ft. long and the bucket capacity 4 cu.yd. The point of operation in the picture is close to the offices and plant

The three 12-cu. yd. diesel driven Euclid trucks that serve the dragline and transport the phosphate muck to the plant

Felix N. Williams, manager of Monsanto Chemical Company, Monsanto, Tenn.

[27] *E.&M.J.* September, 1940.

in 1937, when mining was just beginning, this smaller machine was gasoline-driven, but it has since been electrified, using a 440-v. motor. To serve it when in the field a portable transformer mounted on skids is dragged by a tractor to a point near by, for stepping down the 2,300-v. line current.

From the start the material loaded by these two excavators has been hauled in Euclid trucks with 12-cu.-yd. trailer bodies. Originally gasoline-driven, they are now diesel-powered. They have 5-ft. diameter rubber tires 18 in. wide that permit them to travel loaded on all kinds of roads and even over the open fields if necessary.

A conveniently placed field plant comprised a garage and a diesel oil refueling station for trucks and tractor, with housing for the portable transformer.

With this equipment 1,200 tons of material was being handled per 8-hr. shift, or 2,400 tons for the two shifts that were then being worked on a five-day per week schedule, which also applied to the washer.

The matrix, or muck mined, is split, part being washed and part being sintered direct. The division is made at 10 percent phosphorus, or 50 percent B.P.L., content. Only the material grading below this point goes to the washing plant. Long-range planning for the mining determines the ratio of high-grade to low-grade for sintering, which will vary for the different properties.

That which is sintered direct is taken by the trucks to a hopper which feeds a swing-hammer crusher, having 2,400 lb. of hammers and driven by a 300-hp. motor at 1,170 r.p.m. This is outside the sintering plant. The crushed product is conveyed on a 48-in. belt to storage for sintering.

That part of the muck which has to be washed was being dumped by the trucks, at the time of this visit, in the open near a sump close to the washing plant hopper. As needed, a bulldozer pushed the growing pile into the sump, from which the muck was reclaimed by a Sauerman tower-scraper system having a 2½-cu.yd. scraper and a 125-hp. motor. The muck was thus delivered, a scraperful at a time, to the hopper. The latter discharged on to a grizzly through which the muck was washed by high-pressure water into the first of two McLanahan-Stone log washers in series. Log overflows went to a thickener. From the second log the discharge went to a vibrating screen having 1½-in. holes, the oversize being crushed and sent by conveyor to a storage bin ahead of the sintering plant. Undersize went to a Dorr rake classifier, the overflow of which was thickened (in the aforesaid thickener) and sent to a bowl classifier. Sands from both classifier were sent by a separate belt to storage for sintering, where they were allowed to drain. Overflows from the thickener and the bowl went to waste.

The washing plant was handling 500 dry tons of phosphate muck per 16-hr. day, in the manner described.

An ingenious device was noted for sampling the thickener overflow, which was the final tailing. The overflow was brought in a pipe and discharged into the tailings launder just over the bowl of the bowl classifier. From a hole in this launder fell a ½-in. stream that was intercepted by a covered can with a slot in its top, mounted on one of the revolving arms of the bowl. From the sample thus taken and the venturi reading of the flow in the pipe, together with the weightometer reading and analysis of the sands delivered, the recovery was determined. The tailings pump was a 4,000-g.p.m. Georgia I.W. unit.

A new tailings pond had recently been constructed by building a dam of 98,000 cu.yd. of earth at a selected point, which would permit the pond to back up 1½ miles up a hollow. The overflow pipe was 48-in. Armco culvert.

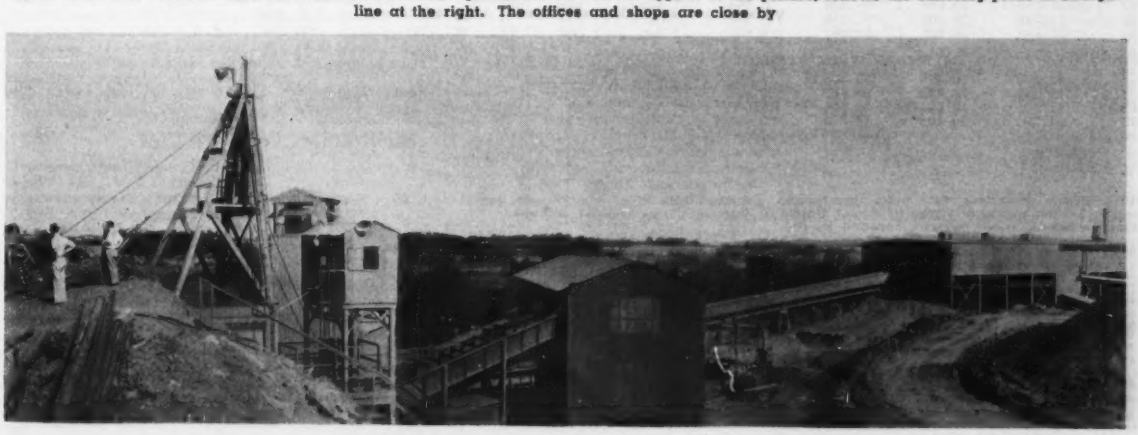
Water for washing, requiring 3,000 g.p.m., and for furnace-slag quenching (requiring 4,000 g.p.m.), is pumped from the river to a 1,000,000-gal. filtering and standard water-treatment installation.

In the sintering plant the American Ore Reclamation Co. process is used. The machine, which when first installed in 1937 had 6 wind boxes, now has 16, giving an over-all length of 96 ft. It is one of the largest installed. Oil was originally used for fuel in the ignition chamber but has been replaced by carbon monoxide from the electric furnaces. The pallets are 96 in. wide. At the feed end is an automatic pallet counter. A 150,000-c.f.m. fan, pulling up to 26 in. suction but actually running with 18 to 20 in., supplied the draft. Its runner is of stainless steel.

Matrix and coke are fed on to the sintering machine feed belt separately from their bins, the matrix being weighed automatically first, after which both are weighed together, the weight of the coke being obtained by difference. Sand is then added, if silica is needed. The bed on the pallets is 12 in. deep at the feed end and finishes at 9 in. The sinter is crushed and the minus-⅜-in. material screened out and returned to the sinter-preparation bins. The sinter weighs 35 lb. per cubic foot. Spillage amounts to approximately 5 tons per day, being mostly cold material.

The sintered matrix, now minus its moisture and free from fines, and with a physical structure that is better for the electrothermal treatment that awaits, goes to sinter storage. This brings to a close the Monsanto story as far as we are able to relate it. The rest is the story of a great achievement in chemical engineering, or will the metallurgist dispute the ground?

Panorama of part of the Monsanto plant, showing (from left to right) the scraper and its tower at the washing plant hopper, the washing plant itself, and the sintering plant. The electric furnace plant, which does not appear in the picture, follows the sintering plant in straight line at the right. The offices and shops are close by



Summary of the

MARKETS

UNDER the mounting rate of armament activity, with consumers increasingly nervous about the supply outlook for ordinary peace-time products, tension in the market ran high as the month of February ended. Official priorities were established during the month for aluminum, and voluntary controls became effective in magnesium and zinc. Copper producers allocated sales. Lead was in greater demand, even at higher prices. Tin moved higher for a time on uncertainty in the Far East.

The *E.&M.J.* price index advanced slightly from 82.48 in January to 82.76 in February, reflecting higher monthly averages for lead and tin.

Consumers of copper were asked to make their wants known so that foreign copper moving into this country for account of the Government may be used in making up deficiencies. The Tariff Commission has been asked to make a study of production costs, which the industry connected with the demands for higher prices from some sections of the country. Inquiry for copper was insistent throughout the last month and those who called for nearby metal again had to pay a premium over the 12c. basis maintained by large mine operators. Domestic sales for February totaled 87,817 tons, against 104,832 tons in January. Purchases of Latin-American copper were increased to the extent of 35,000 tons, making the total so far 235,000 tons. As offerings of "free" foreign copper diminished the export quotation steadied.

Buying of lead was active and the quotation advanced 15 points to 5.65c., New York. Domestic consumption was estimated at 65,000 tons a month, and to supply this tonnage larger quantities of foreign pig lead were released to buyers.

Zinc producers and consumers are cooperating to supply the metal against defense needs and thereby hope to avert official priorities. The quotation for Prime Western was maintained at 7¼c., St. Louis.

Weather conditions slowed the movement of quicksilver from the mines and the quotation advanced about $6 per flask.

UNITED STATES MARKET

1941 Feb.	Electrolytic Copper: Domestic (a) Refinery	Electrolytic Copper: Export (b) Refinery	Straits Tin: New York	Lead: New York	Lead: St. Louis	Zinc: St. Louis
1	11.775	10.325	50.500	5.50	5.35	7.25
3	11.800	10.325	50.350	5.50	5.35	7.25
4	11.775	10.325	50.350	5.50	5.35	7.25
5	11.775	10.350	50.350	5.50	5.35	7.25
6	11.800	10.450	50.350	5.50	5.35	7.25
7	11.775	10.450	50.250	5.50	5.35	7.25
8	11.775	10.425	50.250	5.50	5.35	7.25
10	11.825	10.450	50.250	5.65	5.50	7.25
11	11.775	10.450	50.250	5.65	5.50	7.25
12	Holiday	10.450		Holiday		
13	11.775	10.450	50.625	5.65	5.50	7.25
14	11.825	10.450	51.000	5.65	5.50	7.25
15	11.775	10.450	51.125	5.65	5.50	7.25
17	11.775	10.450	51.500	5.65	5.50	7.25
18	11.775	10.325	51.750	5.65	5.50	7.25
19	11.800	10.325	52.625	5.65	5.50	7.25
20	11.800	10.450	54.250	5.65	5.50	7.25
21	11.825	10.450	53.750	5.65	5.50	7.25
22	Holiday	10.450		Holiday		
24	11.825	10.450	53.125	5.65	5.50	7.25
25	11.875	10.325	52.000	5.65	5.50	7.25
26	11.800	10.450	51.375	5.65	5.50	7.25
27	11.775	10.450	51.175	5.65	5.50	7.25
28	11.775	10.450	51.250	5.65	5.50	7.25
AVERAGES FOR MONTH						
Feb.	11.794	10.414	51.293	5.602	5.452	7.250
AVERAGES FOR WEEK						
5	11.788	10.338	50.383	5.500	5.350	7.250
12	11.790	10.446	50.270	5.560	5.410	7.250
19	11.788	10.408	51.438	5.650	5.500	7.250
26	11.825	10.429	52.900	5.650	5.500	7.250
CALENDAR WEEK AVERAGES						
1	11.792	10.375	50.308	5.500	5.350	7.250
8	11.783	10.388	50.317	5.500	5.350	7.250
15	11.795	10.450	50.650	5.650	5.500	7.250
22	11.795	10.408	52.775	5.650	5.500	7.250

SILVER, GOLD AND STERLING EXCHANGE

1941 Feb.	Sterling Exchange: "Checks" (Nominal)	Sterling Exchange: "90-day demand"	Silver: (c) New York	Silver: London	Gold: London	Gold: (d) United States
1	402.000	(f)	(e)	(e)	(e)	$35.00
3	402.000	(f)	34.750	23.3125	168s	35.00
4	402.000	(f)	34.750	23.3125	168s	35.00
5	402.000	(f)	34.750	23.3125	168s	35.00
6	402.000	(f)	34.750	23.3125	168s	35.00
7	402.000	(f)	34.750	23.2500	168s	35.00
8	402.000	(f)	(e)	(e)	(e)	35.00
10	402.000	(f)	34.750	23.3125	168s	35.00
11	402.000	(f)	34.750	23.3125	168s	35.00
12	Holiday			23.3125	168s	Holiday
13	402.000	(f)	34.750	23.3125	168s	35.00
14	402.000	(f)	34.750	23.2500	168s	35.00
15	402.000	(f)	(e)	(e)	(e)	35.00
17	401.000	(f)	34.750	23.2500	168c	35.00
18	402.000	(f)	34.750	23.3125	168s	35.00
19	402.000	(f)	34.750	23.3750	168s	35.00
20	401.500	(f)	34.750	23.3750	168s	35.00
21	401.500	(f)	34.750	23.3750	168s	35.00
22	Holiday			(e)	(e)	Holiday
24	401.500	(f)	34.750	23.4375	168s	35.00
25	401.500	(f)	34.750	23.4375	168s	35.00
26	402.000	(f)	34.750	23.4375	168s	35.00
27	402.000	(f)	34.750	23.4375	168s	35.00
28	402.000	(f)	34.750	23.3750	168s	35.00
AVERAGES FOR MONTH						
Feb.	401.864	.....	34.750	23.341	....	35.00
AVERAGES FOR WEEK						
Feb.						
5	402.000	.....	34.750	.....	....	.....
12	402.000	.....	34.750	.....	....	.....
19	401.833	.....	34.750	.....	....	.....
26	401.600	.....	34.750	.....	....	.....

Calendar week averages, New York Silver: Feb. 1st, 34.750; 8th, 34.750; 15th, 34.750; 22nd, 34.750.

(e) Not quoted (Saturday). (f) No quotation.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotations deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade Zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout February.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

LONDON MARKET

Feb., 1941	Tin Standard Spot	Tin Standard 3 months
3	256.5000	258.0000
4	256.2500	257.5000
5	256.0000	257.7500
6	256.5000	258.0000
7	256.2500	257.7500
10	256.7500	258.0000
11	257.0000	258.2500
12	257.7500	258.0000
13	259.2500	259.0000
14	263.5000	262.5000
17	266.0000	264.2500
18	269.2500	266.2500
19	271.5000	268.2500
20	279.0000	275.0000
21	282.5000	276.7500
24	279.0000	273.5000
25	276.0000	272.2500
26	270.0000	267.5000
27	264.5000	262.5000
28	266.0000	265.7500
Average for month	264.975	.....

Official tin prices of the London Metal Exchange, in long tons (2240 lb.)

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CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(March 1, 1941)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	17c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	85c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$36.00
Quicksilver, flask of 76 lb., 100 flasks or more	$173.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$10.00
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	(b)$34.00@$36.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$66.70
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 57c.
50 @ 52 per cent	(b) 57c.
46 @ 48 per cent	(b) 51@52c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	(b) $24.00
Domestic, 65 per cent and upward	(a) $23.50
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$48.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3½c
Cobalt Oxide, 70 @ 71 per cent, lb	$1.34
Copper Sulphate, 100 lb	$4.75
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$18.00@$22.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, per pound of Cr contained	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$120.00
Ferromolybdenum 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 percent, gross ton	$74.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.80@$2.00
Ferrovanadium, per lb. of V, delivered	$2.70@$2.90

NON-METALLIC MINERALS

Asbestos, f.o.b. mines (U.S. funds), ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$49
Shorts	$13@$17.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$7.00@$8.00
Domestic, abrasive, 80 @ 84 per cent	$14.00
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Ground, 95 @ 98 percent, bulk, ton	$31.00
Lump, acid, 98 percent, bulk, ton	$27.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	45@60c.
2 x 2 in.	60@80c.
3 x 3 in.	$1.25@$1.50
3 x 4 in.	$1.50@$1.75
3 x 5 in.	$1.75@$2.25
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c.
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.50@$10.50
Vermont, extra white, 200 mesh	$9.50@$10.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$24.50
Basic	$23.50
No. 2 Foundry	$24.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb.	$2.10
Bars, 100 lb.	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1940	1941	1940	1941	1940	1941
January	34.750	34.750	21.892	23.273	395.442	(a) 402.000
February	34.750	34.750	20.935	23.341	395.652	(a) 401.864
March	34.750	.....	20.763	.....	375.212	.....
April	34.750	.....	20.713	.....	351.817	.....
May	34.949	.....	21.878	.....	326.452	.....
June	34.825	.....	22.688	.....	359.560	.....
July	34.750	.....	22.095	.....	379.750	.....
August	34.750	.....	23.261	.....	396.889	.....
September	34.750	.....	23.446	.....	401.646	.....
October	34.750	.....	23.451	.....	401.692	.....
November	34.750	.....	23.238	.....	401.783	.....
December	34.750	.....	23.015	.....	402.000	.....
Year	34.773	.....	22.281	.....	382.325	.....

New York quotations for silver other than newly-minded domestic, cents per ounce troy, 999 fine, London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents. (a) Nominal.

COPPER

	F.O.B. Refinery, Electrolytic			
	Domestic		Export	
	1940	1941	1940	1941
January	11.954	11.819	11.999	10.257
February	11.148	11.794	11.471	10.414
March	11.160	.....	11.407	.....
April	11.087	.....	11.258	.....
May	11.079	.....	11.191	.....
June	11.128	.....	11.216	.....
July	10.564	.....	10.189	.....
August	10.708	.....	9.851	.....
September	11.296	.....	9.849	.....
October	11.826	.....	10.436	.....
November	11.800	.....	10.084	.....
December	11.802	.....	10.293	.....
Year	11.296	.....	10.770	.....

New York quotations, cents per pound.

LEAD

	New York		St. Louis	
	1940	1941	1940	1941
January	5.471	5.500	5.321	5.350
February	5.076	5.602	4.926	5.452
March	5.192	.....	5.042	.....
April	5.071	.....	4.921	.....
May	5.015	.....	4.865	.....
June	5.000	.....	4.850	.....
July	5.000	.....	4.850	.....
August	4.854	.....	4.704	.....
September	4.929	.....	4.779	.....
October	5.308	.....	5.158	.....
November	5.726	.....	5.578	.....
December	5.500	.....	5.350	.....
Year	5.179	.....	5.029	.....

New York and St. Louis quotations, cents per pound.

TIN

	Straits, New York		Standard, Spot, London	
	1940	1941	1940	1941
January	46.707	50.154	240.716	256.648
February	45.851	51.293	242.833	264.975
March	47.079	.....	251.711	.....
April	46.815	.....	252.080	.....
May	51.570	.....	264.098	.....
June	54.618	.....	273.438	.....
July	51.591	.....	265.592	.....
August	51.176	.....	262.455	.....
September	50.348	.....	251.024	.....
October	51.490	.....	257.946	.....
November	50.577	.....	258.214	.....
December	50.101	.....	256.988	.....
Year	49.827	.....	256.425	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		
	1939	1940	1941
January	4.500	5.644	7.250
February	4.500	5.534	7.250
March	4.500	5.750	.....
April	4.500	5.750	.....
May	4.500	5.803	.....
June	4.500	6.235	.....
July	4.516	6.250	.....
August	4.719	6.389	.....
September	6.104	6.920	.....
October	6.500	7.250	.....
November	6.500	7.250	.....
December	5.980	7.250	.....
Year	5.110	6.335	.....

St. Louis quotations, Prime Western, cents per pound.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1940 (a)	1941 (a)	1940	1941
January	79.038	80.000	20.000	17.000
February	80.000	82.273	20.000	17.000
March	80.000	.....	19.769	.....
April	80.000	.....	19.000	.....
May	80.000	.....	19.000	.....
June	80.000	.....	19.000	.....
July	80.000	.....	19.000	.....
August	80.000	.....	18.000	.....
September	80.000	.....	18.000	.....
October	80.000	.....	18.000	.....
November	80.000	.....	17.522	.....
December	80.000	.....	17.000	.....
Year	79.920	.....	18.691	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1940	1941	1940	1941	1940	1941
January	14.000	14.000	156.962	165.846	40.000	36.000
February	14.000	14.000	178.000	170.182	40.000	36.000
March	14.000	.....	180.921	.....	40.000	.....
April	14.000	.....	173.538	.....	38.923	.....
May	14.000	.....	181.538	.....	38.000	.....
June	14.000	.....	197.360	.....	38.000	.....
July	14.000	.....	194.423	.....	38.000	.....
August	14.000	.....	184.111	.....	38.000	.....
September	14.000	.....	173.333	.....	36.167	.....
October	14.000	.....	168.846	.....	36.000	.....
November	14.000	.....	168.391	.....	36.000	.....
December	14.000	.....	164.960	.....	36.000	.....
Year	14.000	.....	176.865	.....	37.924	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk f.o.b. Laredo, Tex., 13.000 for February. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1940	1941	1940	1941	1940	1941
January	23.50	24.50	22.50	23.50	23.00	24.000
February	23.50	24.50	22.50	23.50	23.00	24.000
March	23.50	.....	22.50	.....	23.00	.....
April	23.50	.....	22.50	.....	23.00	.....
May	23.50	.....	22.50	.....	23.00	.....
June	23.50	.....	22.50	.....	23.00	.....
July	23.50	.....	22.50	.....	23.00	.....
August	23.50	.....	22.50	.....	23.00	.....
September	23.50	.....	22.50	.....	23.00	.....
October	23.50	.....	22.50	.....	23.00	.....
November	23.50	.....	22.50	.....	23.00	.....
December	23.50	.....	22.50	.....	23.00	.....
Year	23.500	.....	22.500	.....	23.000	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces.

USEFUL OPERATING IDEAS

Spiral Commutator Grooves Improved Maintenance

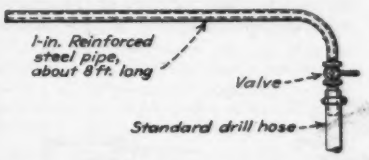
APPLYING THE SCREW conveyor principle to the turning of commutators on 35-hp. mining machines has, in the opinion of some of the maintenance men of a Kentucky operation, retarded development of flat spots from brush sparking. Roasted coils and commutator difficulties were characteristic of these machines under the severe service conditions encountered. Glass-insulated coils have been adopted for rewinds and that improvement, together with the commutator "screw," is credited with a reduction in delays and maintenance.

The commutator surface is finished with a spiral groove $\frac{1}{8}$ in. wide and $\frac{1}{32}$ in. deep. Pitch of the groove is two threads per inch. Under the duty imposed on this type of coal-cutting machine, brush-contact area is considered to be overloaded and it is the supposition that the groove tends to convey sidewise from under the brush any dirt which might cause further overloading in local areas and a resultant increase in sparking. Before use of the spiral grooves the commutators often developed flat spots on opposite sides approximately 2 in. long.

Commutator surfaced with a spiral groove

Air-Operated Barring Device

THE simple and inexpensive barring device shown in the sketch was developed at the property of Nevada-Massachusetts Company, near Mill City, Nev. It has proved useful at the surface loading bins, according to Ott F. Heizer, general manager. As known, a hung-up bin cannot



always be avoided, even if great care is used while dumping, especially when the material contains much fines. During such an emergency, and before the device was adopted, free flow of material through the bin openings was restored by barring down the clogged section with steel bars through the bin gates. This was tedious and not always safe. To speed loading, and at the same time safeguard the man against hand injuries, each bin was equipped with one or two barring devices operated by compressed air. The unit, as shown, is attached to a standard air-drill hose and consists of a piece of 1-in. reinforced steel pipe, about 8 ft. long, and a valve. Whenever a bin section is hung up, the pipe is pushed through the gate and the valve opened. The pressure of the air soon loosens the packed material.

A Novel Gravel-Washing Arrangement

A BOTHERSOME PROBLEM arose recently at the placer property of Dodge Construction, Inc., at Round Mountain, Nev., in the matter of moving a large amount of oversize material to the available dumping ground $\frac{3}{4}$ mile distant, when the sluice already was on bedrock and grade insufficient to sluice it with the limited supply of water on hand. Operations at the time, conducted on a 100-yd.-per-hour basis, were as follows: The gravel was first loosened by a rooter plow and then conveyed by bulldozer to a bin from which the revolving screen was fed. Undersize went directly to the sluice, and large oversize material was cast aside manually and subsequently transported away by bulldozer or truck—a somewhat costly procedure. H. K. Atkinson, the superintendent, solved the problem satisfactorily by installing a small jaw crusher at the discharge end of the revolving screen as shown in the accompanying photograph. Oversize thus was reduced sufficiently in size to be handled in the sluice at a grade and with the amount of water available. The information was kindly supplied by P. Malozemoff, metallurgical engineer, Pan-American Engineering Co., Berkeley, Calif.

A Lime Emulsifier

ADDITION of lime to a cyanide mill circuit should be directly under the millman's control. Use of milk of lime is more economical than feeding burnt lime or slacked lime at the head of the mill. Formerly at the Ipo mine of Benguet Consolidated, in the Philippines, the lime was fed by the trammers from a bin conveniently placed at the crusher grizzly, the lime being regulated at so many shovels per car by the mill foreman, writes John Smeddle, general superintendent. Sometimes the 750-ton fines bin would be full.

When No. 1 thickener was shown to be low in lime, necessitating an increase not only at the crusher but immediately at the head of the mill, as the mill has a grinding capacity of only 200 to 230 tons per day and the effect of increasing the lime at the crusher would make itself apparent only several days after, it was decided to change the system. None of the many emulsifiers I have seen would meet our conditions, inasmuch as we burn our own lime, which is taken from a large deposit close to the mill. This yields a 65 percent CaO product with some rhyolite and conglomerate, which cannot be sorted out conveniently.

At first, we built a small tank, 30 in. in diameter by 48 in. deep, taking the differential out of a junked automobile and using the driving shaft with a hub fitted with two grooves into which were welded two blades of $\frac{3}{8}$x3x26-in. iron to serve as a propeller. One side of the axle drive was fitted with a shaft and pulley and was driven from the classifier drive at 250 r.p.m., with the overflow discharge into the bowl classifier tank below. At first the lime was mixed in a box with holes and slots, the swirl of the solution being depended on to dissolve the lime. This, however, did not work satisfactorily, because of waste in the lime.

We therefore devised a small 24x36-in. trommel with a mill-solution spray on the top and the ends partly closed with a ring, the lime being fed into a 5-in. pipe at the feed end. The solution sprayed dissolves all the available lime, which discharges to the V-launder below and into the emulsifier. The waste, such as rhyolite, andesite and unburnt rock, is discharged over the ring and into a box, which is dumped whenever necessary. The emulsifier is shown in the cut below.

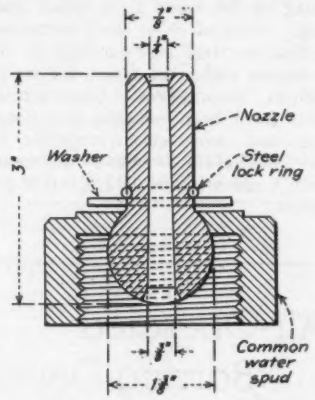
Not only does the emulsifier work well and effect a substantial saving, but it is easily handled by one of the mill helpers, who feeds a measured quantity of lime every hour as may be indicated by the solution man's hourly titrations of No. 1 thickener. In a larger plant the lime could be conveniently fed by a belt feeder or a Challenge feeder directly from a lime bin and the size of the trommel changed accordingly. The present set-up is big enough for a 400- to 500-ton mill. At Ipo, a saving of more than 4 lb. of lime per ton of ore milled was effected.

Five Dollars For Contributions

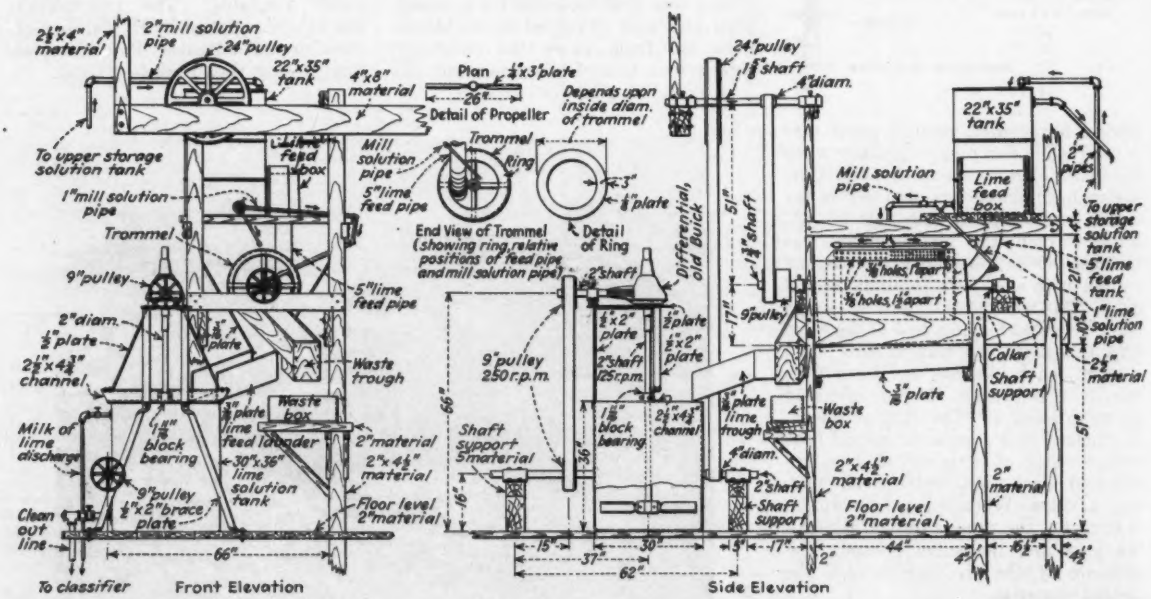
A MINIMUM OF $5 is paid for all Operating Ideas accepted for publication by E.&M.J. about electrical and mechanical kinks or shortcuts to profits as worked out in the field. Rough sketches, photographs, diagrams, and brief descriptions are desired. Why not send some in?

A Blasting Spray

SPRAYING underground working places and broken material is an essential operation if dust hazards are to be reduced to a minimum. In order to enable the operator to carry out this work quickly and effectively, the spray unit should be of simple design and construction, light in weight, and easily operated. Such a spray has recently been developed, and is used with good results in stopes, raises, and lateral workings in the mines of the Copper Queen Branch, Phelps Dodge Corporation, at Bisbee, Ariz.



As explained in the accompanying sketch, the device consists essentially of a brass or stainless-steel nozzle, with a tapered hole in the center and a detachable lock ring made from steel wire and a washer to secure it to a common water spud. The nozzle can be removed from the spud with little effort by simply lifting the spring-like steel ring out of the groove near the spherical end of the nozzle.



PERSONAL ITEMS

Edward F. Richards, Salt Lake attorney, was recently elected president of the Bingham Metals Co.

H. T. Dickinson, consulting mining engineer of Johannesburg, South Africa, recently arrived in New York City on business.

Frank Cameron, manager of La Luz Mines, Ltd., has returned to Nicaragua following a trip to the United States.

Elmer C. Lusk has joined the technical staff of Battelle Memorial Institute, Columbus, Ohio. He is assisting with ore-dressing investigations.

Henry M. Howard has accepted a position as metallurgical engineer with L. Long, Ltd., with engineering works at Orilla, Ontario, Canada.

R. D. Nevitt has resigned his position as research metallurgist at New Occidental Gold Mines, N. L., Cobar, New South Wales.

J. T. Hanvey, Jr., of Portsmouth, Va., has gone to South America as metallurgist for Cia. Minera y Agricola Oploca de Bolivia, Chocaya, Bolivia.

Charles E. Prior, mining engineer, formerly of Vancouver. B. C., has accepted the position of general superintendent of the Fresnillo Co., Fresnillo, Zacatecas, Mexico.

H. Hart Pratley, formerly associated with United Geophysical Co., has withdrawn from that concern and is setting up a new organization for geophysical work in mining and oil-field exploration.

A. E. Fry, Secretary of the Morobe Goldfields branch of the Australasian Institute of Mining and Metallurgy, has been made Mining Warden of the Morobe Goldfield, Territory of New Guinea.

R. D. Price, formerly general superintendent with Spring Valley Mining Co., is now general superintendent of the Silver Palace Mines Co., Inc., at Ione, Nev.

Harold F. Pearson has resigned from the position of manager of Chewton Gold Mines, N. L., to accept that of manager of Golden Transverse, N. L., a new company at Bendigo, Victoria.

Burr Wheeler, who has been general manager for Chile Exploration Co., Chuquicamata, Chile, has taken up permanent residence in New York, with business headquarters at the company's office, 25 Broadway.

H. A. Steane, who recently returned to Australia from Cyprus, where he was on the staff of Cyprus Mines Corp., has been appointed metallurgist to Lake George Mines, Ltd., Captain's Flat, New South Wales.

Maurice G. Alperin, treasurer of the Eastern Smelting & Refining Corp., of Boston, was honored with an appointment by President Roosevelt, on Feb. 3, as a member of the U. S. Assay Commission.

J. G. Bremner has been appointed chief metallurgist to Loloma (Fiji) Gold Mines, N. L., Tavua, Fiji. He was formerly general manager of Consolidated Gold Areas, N. L., Hampton Plains, Western Australia.

Thomas L. Chapman, former geologist of the St. Joseph Lead Co., has been named a director of the Lakeside Monarch Mining Co. During 1940, the mine near Delle, Tooele County, shipped 2,529 tons of ore averaging 13 percent lead and 0.75 oz. of silver to the ton.

Edward Herbert Clifford, until recently associated with the British Ministry of Supply to study the possibilities of increased production of nonferrous ores in the United Kingdom, has been elected president of the British Institution of Mining and Metallurgy for 1941 and 1942.

Col. D. C. Jackling on a recent trip to the Pacific Coast visited the McGill offices of the Nevada Consolidated Copper Corp., of which he is president, after attending a banquet at Salt Lake City at which customary awards were made to 20-year employees of the Utah Copper Co.

His Excellency Rodolfo Michels, newly appointed Ambassador of Chile to the United States, has been associated with the mining industry of his country for the past 20 years. As a member of the Chilean Chamber of Deputies he was the author of laws relating to mining in his country.

A. H. Burroughs, Jr., Boise, manager of the Talache Mining Co., has been elected president of the Idaho Mining Association, succeeding **Irvin I. Rockwell,** of Bellevue. **E. M. Norris,** of Conda, manager of the Anaconda phosphate mine, was elected vice president, and **J. W. Gwinn,** of Boise, secretary.

Earle W. Berry, formerly general superintendent of the Batong-Buhay Gold Mines, of Lubuagan, Kalinga, Philippines, and proprietor of Berry Engineering Co., Manila, Philippines, who has for many years been a reserve officer in the U. S. Navy, is now on active duty with the Navy as lieutenant commander, attached to the office of the Inspector of Naval Material, Philadelphia, Pa.

C. F. V. Jackson retired at the end of 1940 from the position of State Mining Engineer of Queensland. He had occupied the position for over 30 years. He has been succeeded by **I. W. Morley,** previously assistant State Mining Engineer. Mr. Morley formerly was an Inspector of Mines in Western Australia.

E. A. Anundsen is the new district engineer of the U. S. Bureau of Mines in Birmingham, succeeding **Frank E. Cash,** who was recently transferred to Duluth, Minn., as district engineer. Mr. Anundsen was engineer in charge of the Phoenix, Ariz., station before being transferred to Birmingham. He has been with the Bureau since 1929, prior to which he was mine engineer for Verde Central Copper Co., Jerome, Ariz.

Clinton H. Crane, president of St. Joseph Lead Co., and Andrew P. Fletcher, vice president, both of New York, were seriously injured on Feb. 27 in a collision between the auto in which they were being driven to inspect a lead mine near Bonne Terre, Mo., with a motor truck, about 20 miles south of St. Louis, Mo. Mr. Crane, who is 70, suffered a broken thigh, and ankle and head injuries and Mr. Fletcher a broken leg and head and chest contusions. Both are recovering.

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OBITUARY

C. H. Goodsell, mining engineer, prominent in Washington State, recently died at Spokane, at the age of 62.

Matthew VanSiclen, former engineer in charge of mineral research for the United States Bureau of Mines, and recently consulting engineer for the Turkish Government, died in Tucson, Ariz., on March 3, at the age of 60.

Lewis William Morgan, California consulting engineer and metallurgist until his retirement some years ago, died in Los Angeles on Feb. 1 at the age of 92.

Herbert William Ross, well-known California mining engineer, died in Beverly Hills, Calif., on Feb. 9 at the age of 60.

Thomas Lakeside Phillips, prominent in Mexican mining circles, who founded the Fundicion Las Delicias, an iron foundry in Mexico City, died in Mexico City, Feb. 5, aged 77.

John Edward Sullivan, for long a mill employee of the Cia. Minera Real del Monte y Pachuca, S. A., Pachuca, Hidalgo, Mexico, died on Feb. 7. Mr. Sullivan began his mining career in Mexico at the Loreto mill, Hidalgo.

William Chester Madge, mining engineer long prominent throughout the West, and identified also with many mining developments in foreign lands, died at Reno, Nev., on Feb. 12, at the age of 70.

George Klenk, for many years superintendent of Allis-Chalmers Brass Foundry, and well known throughout the United States in non-ferrous foundry circles, died in Milwaukee, Wis., on Feb. 14 at the age of 77.

Donald Ames Loyhed, a Minnesota mining engineer, who had since graduation from the Michigan School of Mines and Technology, in 1924, been employed in South America, Arizona, and Mexico, died on Jan. 11, at the age of 44. At the time of his death he was superintendent of Fresnillo Mining Co. at Fresnillo, Zac., Mexico.

Isidoro M. Luque, for several years mines superintendent of the Cia. Minera The Golden Girl, S. A., Nayarit, died at

his home in Mexico City on Feb. 13. Sr. Luque was widely known in western Mexican mining circles.

W. A. Gosman died at his home at Black Rock, Victoria, on Dec. 30 last, aged 74 years. He was assistant metallurgist of the Mt. Lyell Mining & Railway Co. Ltd., Queenstown, Tasmania, for 30 years, but retired several years ago.

John T. Ryan, president of the Mine Safety Appliances Co., of Pittsburgh, died in Miami Springs, Fla., on Feb. 20. He was 57. Mr. Ryan was an alumnus of Pennsylvania State College, from which he held a B.A. and also an honorary degree in mining engineering. Soon after graduation he became assistant mining engineer of the U. S. Bureau of Mines Pittsburgh station. He worked with Thomas A. Edison in the design and development of the Edison miner's safety lamp. He was a member of many mining associations, and the A.I.M.E.

B. C. M. van der Hoop, a Dutch mining engineer who was vice president of the newly formed Tin Processing Corp., 10 Rockefeller Plaza, New York, N. Y., died on Feb. 27 following an airplane crash near Atlanta, Ga., while en route to Texas City, Tex., to look over the site where the new R.F.C. tin smelter will be erected. Mr. van der Hoop, 42 years old, was born in The Hague and as a mining engineer had spent five years in Bolivia and some time in the Dutch East Indies, Batavia, examining tin deposits for the Dutch tin firm of N. V. Billiton, with which he had been connected since 1932. Mr. van der Hoop had been in this country five months, residing at Scarsdale, N. Y., with his wife and three children.

Edward Alexander Hamilton, general manager in charge of Western operations for the United States Smelting, Refining & Mining Co., died on Feb. 26 at the age of 62. He was born in Sonora, Calif., the son of Achsa and James Hamilton. He attended public school and completed a business course in San Francisco. His father was a mine man and construction contractor, and the younger Hamilton followed mining from the age of 21, when he built a ten-stamp mill and put it to work on the Mother Lode in three months' time. He operated also in Mexico, Nevada, Oregon, Colorado, and Utah. In 1912 he joined the staff of the United States Smelting, Refining & Mining Co., in the mechanical department of the Rainbow mine, in Oregon. Later he went to the company's mines at Leadville, Colo., as superintendent. From Leadville he was transferred to properties in Idaho and then to the United States mine, at Bingham Canyon, Utah, where he was superintendent for five years. In 1924 he joined the staff of the company's Salt Lake office as superintendent of mines and in 1934 he became general manager in charge of Western operations. He was a member of the A.I.M.E. and the American Mining Congress and of several fraternal and civic organizations. Mr. Hamilton was one of the best known and capable engineers in the United States and his loss will be felt throughout the mining world. His friends are numbered in all walks of life; and Utah loses one of its leading citizens.

EDWARD ALEXANDER HAMILTON

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LETTERS

Variations in Sampling and Assaying

The Editor:

THE PAPER entitled "Dangers of Careless Sampling and Assaying," by B. W. Hills, which appears in the October issue of *E.&M.J.*, recalls some observations of my own in a paper concerning variations in results from using the Jones splitter, which was published in *E.&M.J.* in June, 1939.

Both Mr. Hills and I agree that there may be considerable variation in assay of split samples from a Jones riffle if the reduction is not greater than the customary minus ¼ in. In my paper I pointed out that the variation in assays of split samples of average grade ore (0.1 to 0.5 oz.) was from 0.065 to 0.199 oz. per ton, and for high-grade ore the variation was very much larger. These variations in assay were wholly due to the method of reduction, as the assayers were experienced and reliable.

Mr. Hills appears to take sharp issue with the general practice of commercial assayers of crushing only to minus ¼ in. before splitting. I agree that if I had only a few samples from a property for assay, upon which major reliance should be placed, that I would insist that the *entire* sample (presumably about 1 to 2 lb. per foot of sample cut) be crushed much finer than minus ¼ in. before splitting for the final sample to be assayed. I should not expect to get this done for the usual price paid for assaying, and I would prefer to superintend the crushing and splitting myself.

But Mr. Hills overlooks what my experience has indicated, that on a large number of samples from an examination or valuation job, the law of averages asserts itself, and the average of split samples submitted to different assayers, even if crushed to minus ¼ in., will be reasonably close. Individual variations there will be, some distressingly large, but the final averages will check out. This assumes, of course, that at least 100 samples enter into the average.

In the Philippine gold mines the assay office at the mine handles from 50 samples a day for the moderate size mine, to several hundred a day at the large mines. These samples are crushed and split in the conventional manner, and from the results of the assays, the stoping and development work is planned. It follows that from a practical standpoint the methods of sampling and assaying have proved satisfactory, or some other method would have been adopted.

I see no reason to change my opinion expressed in my article. "The practical conclusion appears to be that though the engineer should be wary of placing too much reliance on the assay result of a few samples from a Jones splitter as being truly representative of the ore, he may have considerable confidence in the averages of a large number as being indicative of the true assay value."

WILLIAM F. BOERICKE,
Chief Valuation and Mine Investigation Section, Bureau of Mines, Manila, P. I.

The Editor:

Mr. Boericke's remarks are of interest since in his experience ores of average grade from 0.10 to 0.50 oz. per ton ($3.50 to $17.50 per ton) show variations of only 0.065 to 0.199 oz. per ton ($2.27 to $6.96 per ton) when the sample is crushed to ¼-mesh and reduced in a Jones sampler 1 or 2 lb. before further crushing. However, as pointed out by me, a series of 50-lb. samples submitted to an experienced assayer gave results of $3 to $6 per ton, when samples cut from the same grooves, weighing approximately the same and reduced according to Richard's table, gave results of less than $1 per ton in every instance.

According to Mr. Boericke's figures, the variation is 65 percent high or low on ores of the lowest average grade, and 39 percent high or low on those of the highest average value. In the case I cited above, the variation is much greater, and it would appear that this error would be multiplied when the results of the assays are carried to assay-foot values, particularly so if the vein showed considerable changes in width.

It appears to me that the case is made clear in the "Mining Engineers' Handbook," by Mr. Robert Peel, first edition, p. 1523, "Sampling is the process of securing a more or less representative part or sample for the purpose of gaining information as to the composition of the whole by investigation of the part. . . . The process is *essentially one of approximation; only by special care* can the heterogeneous masses with which the mining engineer usually has to deal be made to yield samples more than roughly representative."

Yreka, Calif. M. W. HILLS

Silver Research

The Editor:

My attention has been called to a misstatement in my article on "Silver" which appeared in the February issue of *Engineering and Mining Journal*. I stated therein that "The American Silver Producers Research Project wound up three years' work at the Bureau of Standards in Washington and elsewhere." I should have made it plain that work was discontinued at the Bureau of Standards only, and that the project was reorganized and transferred to Handy and Harman on June 1, 1940. They are continuing the investigation with emphasis on promoting commercial applications of the developments growing out of the earlier research.

HERBERT M. BRATTER
Washington, D. C.

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1935	74.66
1930	82.87	1936	73.45
1931	60.20	1937	90.86
1932	48.26	1938	73.67
1933	59.79	1939	77.71
1934	69.59	1940	79.22

	1939	1940	1941
January	77.12	80.85	82.48
February	76.89	77.23	82.76
March	77.09	77.94	....
April	74.79	77.19	....
May	73.61	77.68	....
June	73.17	78.85	....
July	71.95	76.72	....
August	73.88	76.71	....
September	83.07	79.40	....
October	84.25	82.49	....
November	83.80	83.14	....
December	82.89	82.42	....

What Metal Statistics Show

THE STRIKE at the copper mine of the Quincy Mining Co., Hancock, Mich., was ended when employees unanimously voted to accept terms of a 90-day contract arranged on Feb. 13 between CIO and company officials. The 540 employees returned to work on Feb. 17. Among the terms of the contract was a wage increase of 10c. per shift for all classes of labor and a sliding wage scale increase or decrease of 10c. per shift for every half cent change in the price of copper, quoted on the Atlantic seaboard.

A committee of copper producers in Michigan has been appointed by Gov. Van Wagoner of Michigan to request national defense officials to peg copper at 15c. a pound. James Greenfield is chairman and other members are William Schacht, president Copper Range Co.; Albert E. Petermann, of Calumet & Hecla Mining Co.; Benjamin Noetzel, of the Isle Royale Mining Co.; S. Lawton, of the Quincy Mining Co.; Gene Saari, organizer for CIO miners' union; and Patrick Thornton, a contractor in Hancock.

The 4c. import tax on copper expires June 30 unless renewed. Interest in the future of this special tariff is growing and small mine operators in Arizona and other mining states are strong in their efforts to retain this tariff.

The duty-free copper statistics of the Copper Institute are summarized as follows, in tons:

	Production (a) Crude	Refined
July 1940	79,327	90,995
Aug. "	79,967	80,851
Sept. "	78,238	82,843
Oct. "	86,911	83,076
Nov. "	84,283	96,283
Dec. "	(b)85,135	97,035
Jan. 1941	83,379	93,327

	Deliveries to Customers: Domestic	Export	Totals
July 1940	71,226	3,532	74,758
Aug. "	96,383	1,336	97,719
Sept. "	96,485	....	96,485
Oct. "	103,771	....	103,771
Nov. "	102,483	....	102,483
Dec. "	112,671	10	112,681
Jan. 1941	119,736	22	119,758

	Stocks, Refined, End of Period(c)
July 1940	215,823
Aug. "	198,955
Sept. "	185,313
Oct. "	164,618
Nov. "	158,418
Dec. "	142,772
Jan. 1941	116,341

(a) Mine or smelter production or shipments, and custom intake including scrap. (b) Corrected. (c) At refineries, on consignment and in Exchange warehouses.

▶ LEAD—With deliveries of lead refined in this country showing no marked change during January, and production higher, stocks at the end of January increased to 47,248 tons, a gain of 6,322 tons.

The figures for December and January, in tons, compare as follows:

	Dec.	Jan.
Stock at beginning	35,791	40,926
Production:		
From domestic ore	47,208	54,658
Foreign and secondary	14,698	7,390
Totals	61,906	62,048
Domestic shipments	56,755	55,711
Stock at end	40,926	47,248

▶ TUNGSTEN — Indirect pressure to control the price situation in tungsten ore is being applied by the authorities in Washington. The Office of Production Management is now releasing supplies stored in this country for strategic purposes to consumers engaged in defense work who would otherwise be forced to come into the open market and bid for ore now in strong hands. Early in February, President Roosevelt signed an order releasing tungsten ore stockpiled by the Government. The Procurement Division of the Treasury controls most of the tungsten ore acquired last year by the Government.

Reserve stocks of tungsten ore are known to be fairly large. Substantial quantities were obtained during 1940 from China against loans made to that country. Imports of tungsten ore during the last year totaled around 7,800 tons. Domestic production amounted to fully 4,600 tons, basis 60 percent WO_3. Normal peacetime use of tungsten ore rarely exceeds 500 tons a month, but during the last quarter of 1940, apparent consumption in the United States probably attained a peak of close to 1,000 tons a month.

▶ ZINC — The January and February statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	Jan.	Feb.
Stock at beginning	12,884	8,768
Production	59,156	55,414
Production, daily rate	1,908	1,979
Shipments	63,272	59,220
Stock at end	8,768	4,962
Unfilled orders	121,026	108,151

(a) There were no exports of domestic slab zinc during the months of January and February.

Figures on operations of the Prime Western division alone, for January, 1941, in tons, follow:

	Production	Shipments	Stock At End
January	25,362	28,209	3,436
February	23,869	26,581	724

Imports of zinc ore (zinc content) during 1940 amounted to 180,655 tons, against 36,099 tons in 1939. Countries of origin, together with tonnages supplied, were as follows:

From:	1939	1940
Canada	1,613	33,995
Newfoundland	.....	23,639
Mexico	23,220	94,123
Argentina	1,544	6,723
Peru	9,722	17,285
Chile	.....	611
Bolivia	.....	2,530
Australia	.....	1,749
Totals	36,099	180,655

Consumers' Stocks of Slab Zinc, November and December

Stocks of slab zinc in the hands of consumers declined 5 percent during December, according to the Bureau of Mines. The zinc inventories for November (revised) and December, based on reports from 306 consumers, in short tons, were as follows:

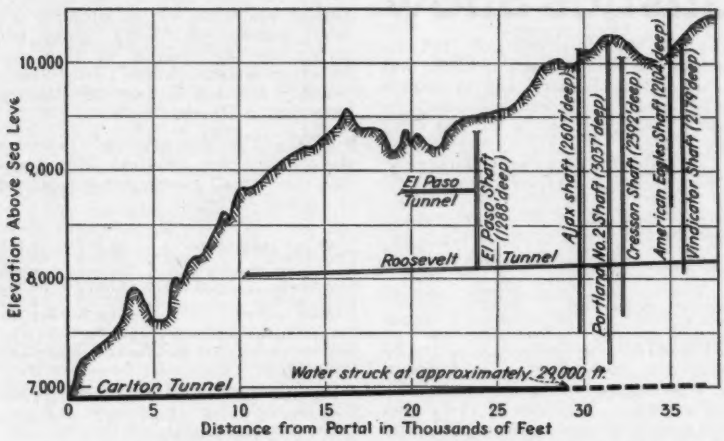
	Special High-Grade (99.99% Zn)	Regular High-Grade and Intermediate	Brass Spec., Selected and Prime West.	Total
November 30:				
Galvanizers	3,028	4,999	32,120	40,147
Die casters	15,309	405	435	16,149
Brass mills	3,440	9,051	4,610	17,101
Rolling mills and oxide plants	534	2,208	5,715	8,457
Other consumers	16	690	.....	706
	22,327	17,353	42,880	82,560
December 30:				
Galvanizers	3,517	4,065	28,307	35,889
Die casters	12,710	361	533	13,604
Brass mills	2,294	13,432	3,824	19,550
Rolling mills and oxide plants	200	2,626	5,522	8,348
Other consumers	313	490	.....	803
	19,034	20,974	38,186	78,194

COLORADO

Heavy Water Flow Struck In Carlton Tunnel

Cripple Creek district happy over event, as some mines above tunnel gradually become unwatered without pumping

▶Water, flowing at the rate of 20,000 g.p.m., was encountered at the Carlton tunnel on Feb. 20, 1941. The bore had been driven to a depth of 28,970 ft., and the heading crews were working in the famous Newmarket fault on that day. Some drill holes were fired at 8 in the morning, that revealed bad, blocky ground that required timbering to hold the back and face. The timbering operation continued all that day. At 5:30 p.m. John R. Austin, superintendent, made a trip of inspection into the tunnel and after looking at the face, ordered the men to abandon the tunnel. Soon after this order had been given, a distant rumbling was heard. As men and equipment were leaving the face, water started to flow from the heading. All were safely transported from the tunnel. The water flow reached a rate of 20,000 g.p.m. at 1 o'clock the following morning. The flow was believed coming from the Ajax mine, 500 ft. above the present heading of the tunnel (see vertical projection), as the 600-ft. water level in this mine receded at the rate of 5 ft. per hour. The Golden Cycle Corporation and the miners of the Cripple Creek district are jubilant, and are discussing the mining expansion program that will gradually come into being as the tunnel approaches its end this year.



Vertical projection of the Carlton drainage tunnel and the important gold mines that will be exploited in greater depth as water is drained from their shafts. The first flow of water struck at 28,970 ft. from the portal reached a flow of 20,000 g.p.m. Early in March this has receded to around 10,000 g.p.m., with the Ajax shaft free of water and water receding slowly in the Portland and Cresson shafts. Drilling will be resumed when the flow reaches around 7,000 g.p.m.

Photo by T. J. Barbre, Denver, Colo.

Tunnel superintendent John R. Austin, who is 6 ft. 8 in. tall, views a major objective virtually accomplished as water flows through the Carlton tunnel, beginning to drain the mine shafts 500 ft. above the tunnel.

▶Russell Gulch Mining Co. has unwatered the Pittsburg mine, cleaned out the 1,100-ft. level, and started drifting on the vein to get under the extension of the main orebody. Shipments of sorted ore carrying about 15 oz. of gold per ton have been made. Milling ore is being stacked while the mill is being remodeled. Frank Manuel is superintendent.

▶The Little Tom Mining Co., under the management of Tom Pierce, of Durango, recently opened a body of ore containing gold, silver, lead, and zinc in sinking operations in the St. Paul mine. This company has carried on small operations for several years and has just come into production.

▶The Old Flack mine, in Nevadaville, has been leased by Tony Babish and George Grant, of Idaho Springs, and rehabilitation of the property is now under way in preparation for operations this spring.

▶Talk of a possible shortage in zinc has caused the New Jersey Zinc Co. to get its underground mill at Gilman ready for production. This mill has been closed down for several years; and during that time large shipments of silver-copper ores have been sent direct to the Utah smelters. The ore consists mainly of zinc-lead-iron sulphide with some silver; and the formation is considered to be similar to that at Leadville. Mine and mill are equipped for large operations, and reserves are estimated at approximately 2,000,000 tons of 15 percent zinc ore carrying lead and iron values. R. L. Jones is superintendent, and Russell B. Paul, of New York City, assistant general manager of all company mines.

▶Harry Williamson, of Denver, operating the Wano Mines, at Jamestown, Boulder County, reports that Herbert Dayoff and Ray Imel have shipped the 85th carload of gold ore from their lease on the Wano Mines. Production is from a gold strike made nearly a year ago, by the leasers. Mr. Williamson is also operating fluorspar properties near Boulder.

▶Summitville Consolidated Mines, Inc., operating its consolidated group of mines and the 125- to 150-ton jig concentration-cyanidation mill at Summitville, worked continuously in 1940. A safety prize was awarded this company for 1940.

▶E. G. Heckendorf has started rehabilitation in the Big Five tunnel of the North American Mining Co. at Idaho Springs, according to H. S. Sanderson, president and general manager of the North American Co. Roy Gartrell, superintendent, is in charge of the work.

▶Work on the Freighters Friend mine, in Gilson Gulch, has been started by A. Porter and K. Kingery. They have cleaned out the 500-ft. shaft to the 300-ft. level; and have made two ore shipments containing gold, silver, and lead, to the Huntington mill on Chicago Creek.

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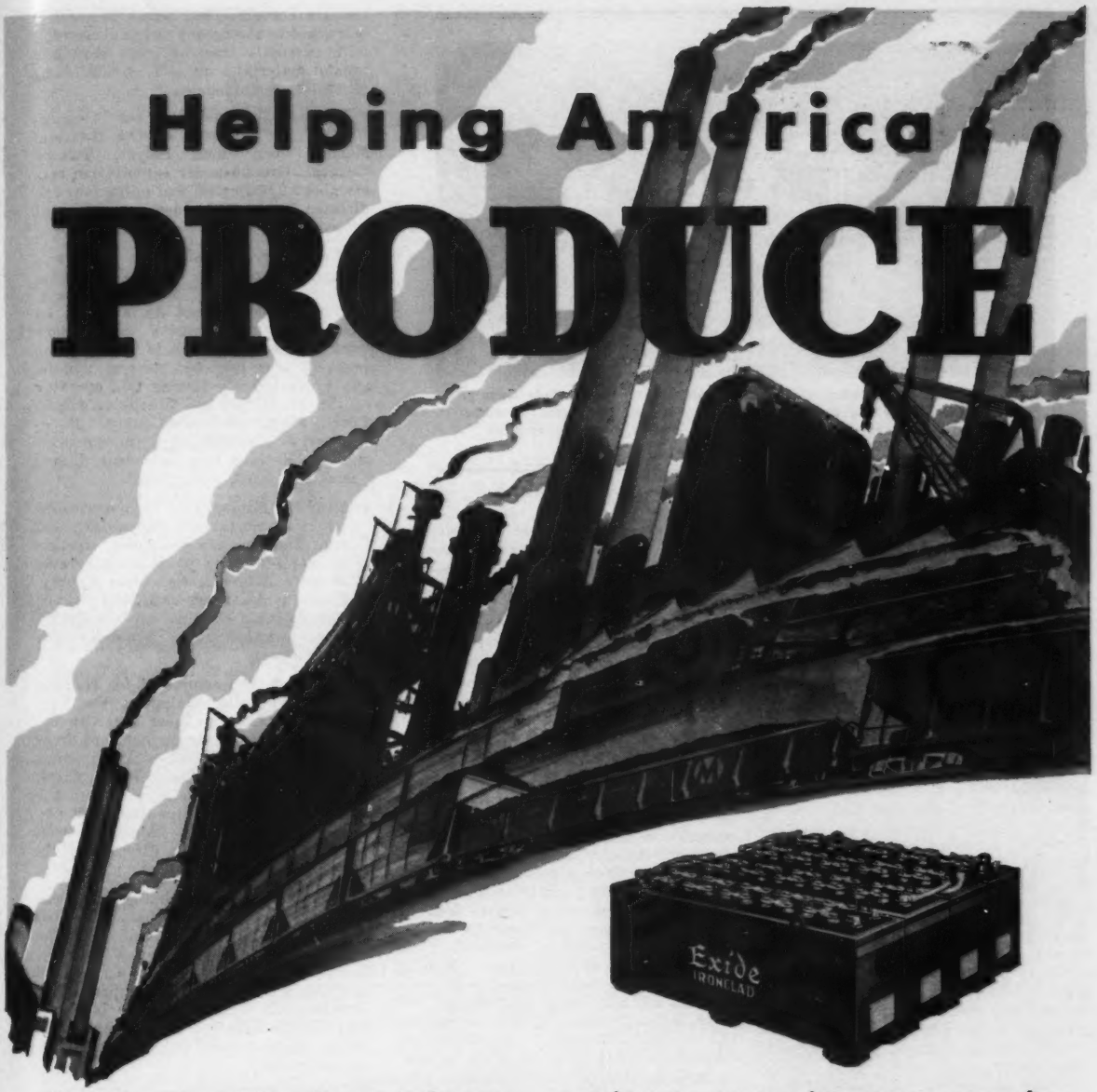

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New 20-ton treatment plant at the Reed quicksilver mine, in Yolo County, Calif., operated by the Bradley Mining Co., of San Francisco. Diamond drilling is planned on the Andalusia area of this promising property

CALIFORNIA

New Quicksilver Plant Completed at Reed Mine

Underground development favorable and future plans involve a diamond-drilling program—Empire shaft of Plymouth Consolidated reconditioned to 500-ft. level.

▶ A new 20-ton treatment plant, consisting of a 30-in. by 36-ft. rotary kiln, condenser system, and auxiliaries, has been completed and put in operation at the Reed quicksilver mine, in Yolo County, by the Bradley Mining Co., Worthen Bradley, president. The company optioned the minerals of the property early in 1939, and subsequent underground work consisted of reopening the lower tunnel (creek level) at the Reed workings, a crosscut adit running 700 ft. west to the vein, and reopening of the old drift both ways on the vein. High-grade ore discovered in 1940 in a winze in the south drift, 200 ft. from the adit junction, was trucked to the company's Sulphur Bank treatment plant, and that found later in the north drift, 700 ft. from the adit junction, is currently being developed by a raise and winze, and drifting. Long-range development plans include diamond drilling the Andalusia end of the property and completion of a 390-ft. raise from the Reed adit level to the surface. Results obtained so far look favorable for installation of additional plant capacity.

▶ Underground work at the Empire unit of Plymouth Consolidated mine, at Plymouth, Amador County, reopened a few months ago by Argonaut Mining Co., Ltd., Alex. F. Ross, superintendent, is proceeding according to schedule. The 1,280-ft. Empire shaft has been reconditioned to the 500-ft. level, with shaft pockets cut on the 400 and 500 levels. Exploratory lateral work on the gold vein has been started on the 500 level. The adjacent cyanide-flotation plant treating tailings from the old Plymouth mill is operating at capacity, handling about 500 tons of material a day. Operations are directed by Hal M. Lewers, superintendent.

▶ Production at the property of Carson Hill Gold Mining Corp., Melones, Calaveras County, is currently maintained on a 1,100 dry tons gold ore per day basis. The flotation plant completed recently at the concentrator is operating satisfactorily, and a second agitator has been cut in on the sulphide circuit at the cyanide plant. At the mine, sinking of an incline shaft from the 3,500 level is planned. Material handled at the concentrator is mined on the 1,100, 1,350, 1,600, 3,000, 3,160, 3,325, and 3,500 levels, and from open pits. John A. Burgess, general manager, is in charge of operations.

▶ Construction of a new cyanide concentrate treatment plant is progressing steadily at the Argonaut gold mine, at Jackson, Amador County. When completed the unit will handle concentrates from the Argonaut mill, now treating up to 8,800 tons of ore a month, flotation concentrates from the Plymouth tailings plant, and those to be produced at the Empire mine, at Plymouth. Drifting south to explore new ground is in progress on the 4,800 level, and stoping and drifting are now carried on on the 6,150 and 6,300 levels. The concentrate treatment plant is expected to be completed by April 1. The Argonaut mine is operated by the Argonaut Mining Co., Ltd., Alex. F. Ross, superintendent.

▶ A new hoist has been installed and sinking of a winze is in progress on the 3,500 level, about 1,500 ft. north of the Old Eureka shaft, at the property of Central Eureka Mining Co., Sutter Creek, Amador County, to establish and explore lower levels. Gold ore is mined on the 2,500, 2,900, 3,000, 3,100, 3,300, 3,400, and 3,500 levels, with the mill treating about 5,000 tons of ore a month. A model change house for 200 men has been completed recently, adjacent to the Old Eureka shaft. Operations are directed by James Spiers, general superintendent.

▶ Mining and milling operations are proceeding steadily at the property of Keystone Mine Syndicate, Amador City, Amador County. In the Patton shaft, which is open to below the 2,100 level, exploratory work and mining of gold ore is done on the 1,200, 1,400, 1,800, and 2,100 levels, and in the South Spring Hill shaft all activities are above the 800 level. Mined ore is trucked to the nearby Original Amador mill, currently treating more than 300 tons of material a day. T. S. O'Brien is general superintendent.

▶ Two hydraulic monitors are in operation at the property of the Swanson Mining Corp. near Salyer, Trinity County. Ground under exploitation covers about 2,000 acres, and operations are directed by A. J. Swanson, president of the company.

▶ The Jenny Lind shaft on what was formerly known as the Washington mine, near Hornitas, Mariposa County, has been reconditioned to a depth of 1,500 ft., and extensive development work on the lower levels is planned. The property was reopened several months ago by the Pacific Mining Co., operator of the Pine Tree and Josephine mines, Bear Valley, Mariposa County. P. R. Bradley, Jr., is manager of the company, and Joel Kiviaho, superintendent, directs operations at the Jenny Lind.

▶ Altaville Mining Co., Inc., controlled by J. Cadamortari, L. Cepanich, and George Engelke, has completed erection of a gravel-washing plant at its gravel mine near Altaville, Calaveras County. The mine is developed by a 350-ft. shaft, and systematic drifting on the gravel channel is under way. About 14 men are employed.

▶ Work has been completed for resumption of hydraulic mining at the Lost Camp hydraulic mine, near Blue Canyon, Placer County. Water is obtained from Monumental Creek, East Monumental Creek, Sailor Ravine, and Fuller Creek via a 16-mile ditch discharging into the reservoir serving the pipe line, with two monitors at the mine. About 20 men are employed under the direction of L. F. Johnson, superintendent.

▶ Installation of new hoisting equipment and an air compressor has been completed at the New Brunswick mine of Idaho Maryland Mines Corp., Grass Valley, Nevada County, and erection of a new steel headframe over the shaft is proceeding satisfactorily. Errol MacBoyle is executive vice president of the company, with Albert Crase, general manager, in charge of operations.

▶ Walter W. Bradley, State Mineralogist of California, calls attention to an amendment to the original Act relating to loans by the Reconstruction Finance Corporation, which extends the authority of the R.F.C. to make loans for the development of deposits of any strategic or critical mineral of value in time of war. The amended Act was approved Sept. 16, 1940. By it, the R.F.C. is authorized and empowered to make loans to corporations, individuals, and partnerships engaged in the development of a quartz ledge, or vein, or other orebody, or placer deposit, containing gold, silver, or tin, or gold and silver, or any strategic or critical mineral which in the opinion of the R.F.C. would be of value to the United States in time of war, when, in the opinion of the R.F.C., there is sufficient reason to believe that through the use of such loan . . . there will be developed a sufficient quantity of ore, or placer deposits of a sufficient value to pay a profit upon mining operations.

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NEWS FROM Washington

By Special Correspondent

SHORTAGES OF METALS are causing serious concern in several sections of official Washington early in March. Of greatest immediate concern are aluminum, magnesium, zinc, brass, and nickel. It is proving something of a surprise to the planners of the Army and Navy that the things which they thought were going to be critical strategic metals are not at all those which now give official worry.

Obviously, it is the tremendous defense program which has occasioned these shortages. And when some of these bottlenecks are removed, it is almost sure that others will take their place. Apparently, construction of plant facilities and supply of labor are almost certain to keep well ahead of raw-material supply in all of the major fields where the nonferrous metals are involved. And no one knows how much more serious these nonferrous shortages may become next year when full manufacturing activity in the new ammunition plants and defense-equipment works really starts.

Priorities have, of course, been officially established on some of these metals. Voluntary rationing by industry has been adequate for others, but each individual metal offers a problem with quite distinct aspects.

Aluminum Plans

THE FIRST METAL to be officially regulated by formal priority rules was aluminum. Despite strenuous effort of aluminum producers to expand electro-chemical capacity, the demand for direct military usage overtook supply quite conspicuously in February. Shipments by primary producers were at that time officially restricted to those who had defense manufacturing orders. Others are, for the present at least, without supply of aluminum raw material. Of course, it is hoped, but not too confidently expected, that civilian needs will get their normal ration of this light metal again when projected reduction plants have been completed.

Aluminum Company of America has continued the leader in new plant expansion, but Reynolds Metal Company began construction of a plant some months ago, with the plan to use TVA power. During the latter part of February, RFC Chief Jesse Jones announced that this company was going to be given further financial aid, if necessary, for its plant now projected for the Columbia River valley. Near the end of the month, the Bonneville Authority announced that a contract had been closed with that company for supply of 40,000 kw. of Bonneville power.

The site of the new electrolytic plant was not immediately announced. But its capacity is officially stated to be 40,000,000 lb. of metal per year. Beginning of production is scheduled for June 15 of this year. The official understanding is that domestic bauxite will be taken to Sheffield, Ala., for manufacture of pure alumina. That raw material will then be used in both the Valley plant and the new Bonneville works.

Government officials decline to estimate either the required supply or the probable capacity for primary aluminum in the United States for 1942. But it is evident from the program, not all of which has yet been announced, that about a billion pounds of this light metal per year is both needed and expected, beginning in 1942. One comment is, "That will clothe a lot of tubes of toothpaste." But it will not make more airplanes than are hoped for; and even it may not leave any margin for civilian supply of pots and kettles etc., in the early future.

Magnesium Program

LATE IN FEBRUARY there was official confirmation of the first big step in the government encouragement of magnesium manufacture in the United States by anyone other than Dow Chemical Company. At that time the definite arrangements being made to stimulate Permanente Corporation in building its plant near Palo Alto, Calif., were made public. At the same time it was officially recognized that several other producers were also desired for this light metal.

In the aggregate, it appears that the government will not be really satisfied until United States productive capacity for magnesium reaches 100,000,000 lb. per year. Magnesium is second only to aluminum in urgency of attention. It was also second among metals for which official priority control of new production was established. Only those persons using this metal for defense construction work will now be supplied if Dow conforms with the "request" of Mr. Stettinius of Feb. 13. And there surely will be compliance.

At least a half dozen other companies experienced in chemical or metallurgical enterprises are known to be critically studying magnesium possibilities. The government is encouraging all of these firms to press their plans as aggressively as possible. Several of the companies are reported to be operating small pilot-scale units in anticipation of formulating plans and possibly embarking on full commercial plant programs. None of these undertakings has, however, had official recognition by public announcement up to the first of March.

Permanente Plans

DEVELOPMENT of the Permanente contract has occasioned much comment and considerable speculation about Washington. The matter took on a peculiar flavor when it became known that Thomas Corcoran, formerly of RFC staff and high-ranking New Dealer, had been the adviser of those arranging for official aid in this matter. The facts of the case seem rather simple.

Henry Kaiser and his associates came to Washington to arrange their plans for their magnesium enterprise. They, like others, were told that the government did not wish to make a direct contract for production of the metal on the government account. The preference was that those firms having airplane or aircraft-part contracts should be the purchasers. The only encouragement offered to any of these firms discussing magnesium was the possibility of a loan and the surety of a certificate of necessity.

Very promptly Permanente Corporation received such certificate. This assured it the privilege of a 60-month capital amortization plan under the recent Congressional act. The company applied for an RFC loan, and late in February such loan for approximately $9,000,000 was announced. Mr. Corcoran apparently assisted in preparing the case as any other lawyer in private practice might have assisted. He was free to do this because he retired from the staff of RFC some time ago.

The process proposed for use by this company is one devised by an Austrian citizen, Dr. Hansgirg. The first plant to use his process was erected under his supervision in Austria. It began operation there several years ago but was destroyed by an explosion in 1939. Official Washington understands that it has not been rebuilt. Dr. Hansgirg participated in the planning and erection of another plant to use his process in Korea, working for an agency of the Japanese Government. That plant began operation last year, but rumor has it that it has never functioned satisfactorily at capacity. A third plant to use a modified form of the Hansgirg process has been built by British interests near Swansea, Wales. It, too, is reported to have some operating difficulties, but Dr. Hansgirg is quoted as saying that these have resulted from the changes in furnace design which the British chose to make.

The importance of Dr. Hansgirg to the process is well recognized. It is reported that his stay in the United States would normally be difficult, as his visitor visa perhaps could not be extended further under ordinary circumstances. However, it is understood that every effort is being made to secure an extension so that he may assist with technical advice and supervision on the Permanente enterprise. Incidentally, that company prepared its design and bought equipment, during February. The plant was actually under construction on the first of March.

Alloying Metals

THE STRATEGIC METALS used as ferro-alloys for steel manufacture have been giving less concern in Washington than most had thought possible. However, a few significant shifts have occurred during February.

The first use of stockpiles was made on authorization of the President by removal of a limited quantity of tungsten from the military reserve for alloy-steel manufacture. This appears to be the only metal for which the official reserves have thus far been drawn on. Even this use of the reserve stock would not have been necessary if sufficient cargo space had been available to bring purchases from the Orient to the United States.

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Naturally, government men hope that similar transport difficulties will not develop in other strategic materials, so that the reserves need not be reduced at this early stage in the emergency.

Nickel shortage has caused much concern because in a few cases it is definitely known that important contract manufacture is held up because of the limited supply of nickel available to make stainless steel. In general the figures of imports from Canada would seem to indicate an abundant supply. Officials suspect hoarding, and are investigating.

Manganese economy is definitely recommended in an official report of the metallurgical group advisory to the O.P.M. metals unit. That committee in a release of Feb. 21 outlined methods for substitution of spiegeleisen for ferromanganese and for other modifications of metallurgical practice. The committee concludes that 20 percent of the present consumption of manganese in the form of ferro could be saved by appropriate changes of this sort. It therefore urges increased production of spiegel which can be made from the lower-grade ores, especially those of domestic origin.

Copper and Zinc

NEXT TO ALUMINUM and magnesium the problems of supply of zinc and brass have been of greatest concern to the metals division of O.P.M. For a while during early February it seemed definitely necessary to establish priorities for control of brass and its component metals. But voluntary rationing was still continuing at the end of February. How much longer this could last was a question.

Zinc shortage was very real. The immediate difficulty is shortage of primary smelting capacity. Until this is corrected by completion of construction now under way there will be difficulties. And some folks think that the capacity never will catch up with the demand, because of the tremendous prospective need for brass and other zinc alloys as the ammunition assembly program gets fully under way late this year and early in 1942.

Copper supply will continue abundant if shipping to bring Chilean copper is available during all of 1941. The second purchase of 100,000 tons of copper from Chile had hardly been announced when talk began of a third order. At the end of February this resulted in a purchase of 35,000 tons of additional metal. As yet there is no evidence as to how much Latin copper will be needed altogether. It is safe to conclude, however, that whatever we need this year or next we shall buy it in Latin America. Price controls will continue effective, everyone believes.

Trade Controls

MOST of the new regulations of international movement of metals and minerals imposed recently follow the pattern established by earlier actions. Export licenses are now required for beryllium and graphite electrodes as well as a number of medicinal and industrial commodities.

Rationing of an entirely informal sort is being practiced already on many commodities. Other paragraphs in this news summary indicate the way in which more drastic official regulation is being applied to aluminum, magnesium, zinc, brass, and some of the ferro-alloying elements.

Aggressive but informal action was taken to survey stocks of nickel in the hands of consumers during the last week of February. The Bureau of Mines was given the responsibility for this fact-finding study. If the response proves adequate, and accurate, this technique may continue. But there is plenty of authority, which the President and O.P.M. will not hesitate to use for more severe attack on hoarding, if evidence of unwillingness to cooperate is shown in these surveys.

Plastics as Substitutes

STRENUOUS EFFORT is being made to secure substitution of other materials for those of which the supply is not all that is desired. The substitution of spiegel for ferromanganese is one simpler form of replacement recommended. Even more drastic changes are being urged in some industries.

During mid-February Mr. Stettinius urged that all manufacturers undertake to substitute plastics for metals on which they were experiencing shortages. This suggestion has not received much favorable comment among well-informed industrialists. They realize the fact, which apparently Mr. Stettinius did not, that plastic shortage of even more fundamental sort might soon develop if there were general adoption of this suggestion. The fact is that it would take more time, money, and skilled workmen to build up a new plastics supply of, say, 1,000,000 lb. than it might take to develop an equal quantity of some of the metals for which replacement was suggested. Certainly, this is true of magnesium and aluminum, for which substitution was first recommended.

News "Fines"

Copper Price Fixing?—Three interpretations are given to the announcement that the Tariff Commission is to make immediately an investigation of the "cost of production of copper" and the "relationship of costs, prices, and wages in the copper industry." One impression is that this is a first step by which Defense Commissioner Henderson intends further to control the price of this metal. Second, the purpose might be to lay a basis for cutting the 4c. excise tax on first fabrication of imported copper. The third possibility is that this fact-finding study of the Tariff Commission will be used to settle any labor difficulties, such as the recent Michigan copper miner wage dispute. Settlement of the strike, however, was made by a 90-day contract on Feb. 13 between the Quincy Mining Co. and CIO.

New S.E.C. Forms—The revised form S-3 of S.E.C., long expected, was made available to the mining industry for review and criticism late in February. This proposed new form is designed to provide a much simplified procedure of registration where a company requires only a relatively small new capital security issue for promotional and developmental work. It is anticipated that it will be peculiarly useful to the mining industry, as the old forms were often almost impossible of use in view of the uncertainty necessarily involved.

Priority Rules—Under date of Feb. 17 there were released by O.P.M. definite rules which give the procedure to be followed under the priorities system. Any firms producing or requiring materials which now are, or soon may be, regulated by official priorities, must conform with the practices there outlined.

Tin Price—When Far Eastern affairs threatened to cut off tin imports completely, prices spurted upward. This brought a sharp rebuke from O.P.M. Executive Harriman. He pointed out that hoarding by individuals was futile. All such stocks would be commandeered in the event of serious shortage.

Office of Production Management, Washington, D. C.

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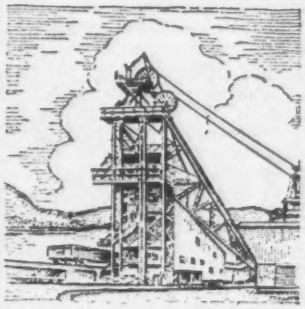

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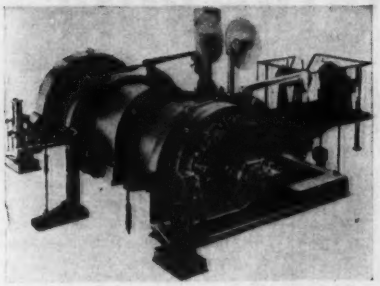

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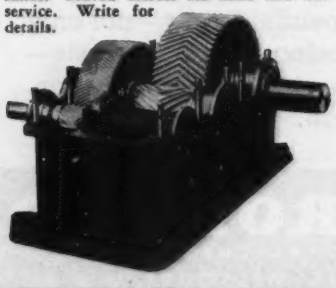

OTTUMWA IRON WORKS

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Dayton Consolidated Mines Co. was the largest gold producer on the Comstock lode in Nevada during 1940. The cyanide plant of the company, shown above, treats ore on a custom basis trucked from many districts

NEVADA

Two Companies Project Larger Mill Capacity

Plant construction planned by Goldacres Consolidated Mining near Beowawe, Lander County, and Crater Range Gold Mining Co. in Elko County

▶ Construction of a larger cyanide mill was said to be planned by heads of the Goldacres Consolidated Mining Co., to treat low-grade gold ore from a surface deposit on claims adjoining the Goldacres mine, described in a recent issue of the *E.&M.J.* by E. J. Bumsteal, manager. The mines are in the Tenabo district in Lander County, 24 miles south of Beowawe, the rail point and postoffice. E. A. Moynahan and H. C. Bishop are in charge for the new company.

▶ Having developed a large volume of gold ore of high mill grade in the formerly productive Bluster and Success mines, in the Jarbidge district, northern Elko County, the Crater Range Gold Mining Co. is preparing to construct a 100-ton mill to replace the dismantled 60-ton cyanide plant. The 3,200-ft. aërial tram from the main 1,800-ft. tunnel to the millsite has been repaired, E. R. Lund, manager, reported.

▶ Ore that is said to contain from 0.50 to 1.50 percent cobalt, taken from an old copper mine at Goodsprings, Clark County, is being treated with specially designed flotation equipment in the mill of the Barefoot Leasing Co., west of Goodsprings. Otto F. Schwartz, president and manager, stated that production is from 500 to 1,000 lb. per day of concentrate containing 26.50 percent cobalt.

▶ Shipments of barite during last summer and early fall from two deposits in northern Lander County aggregated 227 carloads. The product was mined and shipped by the Glidden Paint Co., with a refining plant at Oakland, Calif., and the Barium Products Co., Ltd., with a plant at Modesto, Calif. Other deposits in Lander County are described in a technical paper prepared for A.I.M.E. publication by Vincent P. Gianella, geology professor at the Mackay School of Mines, in Reno.

▶ Property known as the Cahill cinnabar mine, owned by Jack Cahill, of Reno, and situated in the Hot Spring range in eastern Humboldt County, has been acquired under option by E. T. Fisher, mine operator of Boise, Idaho, for total price of $150,000, the optionee having made a cash payment of $30,000. In five months last year the small furnace produced more than $80,000 worth of mercury from ore with content ranging from 30 to 55 lb. per ton.

▶ A 35-ton pilot mill employing amalgamation and table concentration has been completed and was reported operating with success on gold property of the Currant Creek Mining Co. in the Currant district, northeastern Nye County. Charles M. Richardson, president and manager, has his office at Ely.

▶ The connected-bucket dredge of the Manhattan Gold Dredging Co., reported to be handling 14,000 to 16,000 cu.yd. of gravel per day, having started at a point in the wide flat a mile from the outlet of Manhattan Canyon, has worked its way upward to the narrow part of the canyon, where it is said to have been washing gravel of high grade. John L. James is in charge at Manhattan for the Natomas company, which owns a 20 percent interest and operates the dredge.

▶ A vertical drill hole sunk 1,900 ft. from the 900-ft. level of the Locan shaft of the Richmond-Eureka Mining Co., 2 miles west of Eureka, has been abandoned by the E. J. Longyear Co., drilling under contract for the Eureka Corp., Ltd., of Toronto, and the equipment has been moved to another point on the same mine level, where the Richmond-Eureka management started drilling around 1923. The purpose of diamond drilling, interrupted by the broken nature of the limestone, has been to prospect for ore beyond the Ruby Hill fault. William Sharp is manager for the Eureka organization.

▶Consolidated Coppermines Corp., with mines at Kimberly, White Pine County, is shipping 9,000 tons of copper ore per day to the Kennecott smelter at McGill.

▶Production in 1940 of the Desert Silver, Inc., operating the Nivloc mine, near Silver Peak, in Esmeralda County, was 743,032 oz. silver and 4,219 oz. gold from 69,016 tons of ore treated in the 200-ton cyanide mill. A force of 150 men is employed. The Nivloc postoffice has been established at the mine, which is the largest producer of silver in Nevada. Ira B. Joralemon, of San Francisco, is president and Fred E. Gray is manager at Nivloc.

▶Dayton Consolidated Mines Co., operating mines and two mills near Silver City, Lyon County, had its most productive year in 1940, treating 87,806 tons of ore. The bullion produced contained 32,095.94 oz. gold and 237,047.08 oz. silver. Homer L. Gibson is president and managing director at Virginia City.

▶Meeting in Elko, stockholders of the Rip Van Winkle Mining Co. and of the Rip Van Winkle Extension Mining Co. approved a merger of the two corporations. The new company is titled the Rip Van Winkle Consolidated Mining Co. The property, embracing some 40 claims, includes the old Rip Van Winkle mine, at Lone Mountain, in the Merrimac district, 35 miles north of Elko. Control and later complete ownership were purchased in 1919 from Elko owners by a Utah group including officers of Utah Copper Co., who provided a 100-ton selective flotation mill, closed down late last year for lack of ore. Lately new orebodies have been opened on deep levels. Directors of the new company include J. D. Carter and L. S. Breckon, of Bingham Canyon, Utah, and George B. Thatcher, Pat Mooney, and William Woodburn, of Reno, with representatives of Colorado broker interests. L. S. Breckon, geologist for Utah Copper, continues as directing engineer and M. E. Bohannan is mine superintendent.

ARIZONA

Oro Plata Mine to Resume Operations

Mill capacity planned to be increased—Many small operators shipping ore to plant of Producers, Inc.

▶It is announced by officials of the Davenport Mining and Reduction Co. that they will resume operations on the Oro Plata mine, in the Layne Springs section 15 miles north of Kingman. The mill of the Davenport company has been under lease to the Gold Cliff Central Co. for several months, operating on ores taken from the Little Golgonda and Mexican mines. Capacity of the mill is planned to be increased. Ogden C. Chase of Las Vegas, is president of the Company.

▶The mill of Producers, Inc., 6 miles west from Chloride, in Mohave County, is operating at capacity treating 250 tons of ore every 24 hours. The record of the past three months shows that over fifty different mining properties have shipped ore to the company's mill.

A 5-minute sandblast operation resharpens Sinta-Set Bits. Compact, economical equipment available.

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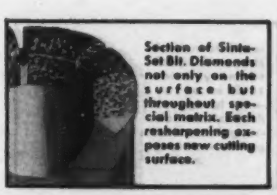

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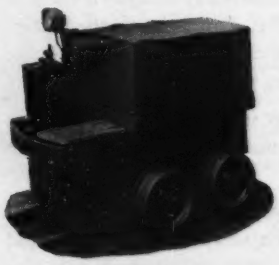

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Among mining properties near Chloride is the Arizona Magna mine, the principle production of which is gold and silver. The ore also contains some argentiferous galena, but the concentrate contains about 3 per cent lead. Cut-and-fill stoping is the mining method generally employed at the mine.

▶ARIZONA

▶Molybdenum Corporation of America, operating the Boriana tungsten mine, in the Hualpai Mountains 25 miles east of Yucca, is employing about 120 men. The mine is operating on two shifts and the mill one shift. An average of 1,200 tons of ore are treated monthly. H. L. Weach is in charge. A new electric line is being constructed to the mine from Kingman with power to be supplied from Boulder Dam.

▶Little Butte mine, 5 miles west of Bouse, reports finding a gold-bearing orebody on the 200-ft. level. It is said the ore was overlooked by previous operators failing to crosscut to either the foot wall or the hanging wall. The property is operated by the Associated Mines Co., headed by E. M. Cregar, of Salome, Ariz.

▶Construction of a 150-ton lead-zinc smelter is planned for Bisbee Junction by Minas Artemisa, S. A., of which Frank O. Jasmer is resident manager, his address being Estacion Poza, Sonora, Mexico. The smelter will be supplied by ores from the company's mines in Sonora, Mexico.

▶Oatman Mines, Inc, has installed a new hoist, compressor, and other equipment, built a new roadway, and cleared the old shaft to the 200-ft. level, where lateral development will be continued. Frank DeClark is superintendent of the work.

▶Ari-Butte Operating Co. is shipping high-grade ore and concentrates from its properties in the Bunker Hill district near Sombrero Butte. The mill is operating on a two-shift basis and is expected to move to a 24 hour basis soon. O. W. Blevins, of Sombrero Butte, is directing operations.

▶King of Secret Pass Mining Co. has found gold ore at a depth of 191 ft. in its shaft, and drifting has started along the vein in both directions on the 200 ft. level. Warren MacElroy is in charge.

▶The Ox Bow group of mining claims, 21 in number, situated near Payson, have been purchased by Paul J. Harrison, of Long Beach, Calif. The purchase was made from Major John P. L. Walker, of Pawtucket, R. I., owner of the property. Several hundred feet of development work has been done on the ground and recently a shipment was made from a new strike which gave returns of 14 percent copper, $8 in gold, and $1.50 in silver.

▶The Oro Fino mines, in the Oro Blanca district, near Ruby, are being developed by the Edgehill Equipment Co., of Huntington Park, Calif. They plan the construction of an amalgamation-concentration plant. Power will be supplied by 100-hp. diesel engine. M. E. Pope and W. J. Williams, of Huntington Park, are owners of the property.

▶Red Rover Copper Company, north of Cave Creek, is mining 100 tons of ore daily and the concentrates from the mill are shipped to the Magma smelter, at Superior, at the rate of a carload a week. Most of the ore is taken from the 725-ft. level, and development is progressing on the 900-ft. level. Power is generated by a 400-hp. diesel engine. Bernard Gillespie, of Cave Creek, is owner and general manager.

UTAH

Exploration on Manganese Deposits Encouraging

Diamond drilling reveals ore beyond mineralized area in Juab County—Tungsten plant being completed near Milford

▶Exploration work seeking defense materials is meeting with encouraging results, according to reports emanating from the U. S. Bureau of Mines Station at Salt Lake City. Under the direction of Dr. R. S. Dean, chief engineer, metallurgical division, treatment procedure is being developed on a laboratory scale for manganese minerals. Two pilot plants are being completed at Boulder City, Nev., prior to the construction of a commercial plant. Diamond drilling of manganese deposits at Drum Mountain, Juab County, has proved certain additions to the known mineralized area, Paul T. Allsman, engineer in

charge of the mining division at the Salt Lake Station, reported recently. Testing of a deposit near Manila, Daggett County, is to start in the spring. In Nevada, the mining division is examining quicksilver deposits near Battle Creek, near Winnemucca; tungsten deposits in Pershing and Humboldt counties; manganese near Valmy; nickel at Bunkersville; and manganese near Las Vegas.

▶ Prosper Mining Co. is completing its 30-ton milling plant for the treatment of tungsten ore from the Old Hickory mine, near Milford. Ray Spykeman is in charge of construction.

▶ The European war has cut into the sales of gilsonite mined near Roosevelt by the Raven Mining Co., reports Fred C. Ferron in charge of operations. L. F. Lindley, of Chicago, is president. Normal production now between 500 and 1,100 tons per month is 35 to 40 percent below what it was before the war.

▶ The Silver King Coalition Mines Co., at Park City, reported a net profit of $467,075.95 for the year 1940 ending Dec. 31, compared with $387,924.12 for the year of 1939. About 750 men are employed in the mine and mill.

▶ A 5-ft. fissure carrying copper ore was struck recently in the Kentucky-Utah mine, Big Cottonwood Canyon, 8,600 ft. from the portal of the 9,000-ft. tunnel. Samples averaged $1.50 a ton in gold, 2 oz. of silver, and 9 percent copper, Secretary M. C. Morris said.

▶ Operators in Beaver County have organized the Milford Mining Association to register a list of mining properties and publicize mining resources. Edward Schoo, president of the Prosper Mining Co., is president; Harry Jefferson, vice president; and John Moore Williams, secretary-treasurer.

▶ Treasure Hill Mines Co. is preparing to ship ore from the deposit recently struck in its Madison Mines Co. lease, Dry Canyon, Ophir section.

▶ Driving of the Mountain Mines Co. adit, Big Cottonwood Canyon, has passed the 2,200-ft. mark, according to Charles S. Woodward, president and manager. The Mercur Dome shaft, at Mercur, has reached a 750 ft. depth, with 150 ft. to go to reach the objective Madison limestone.

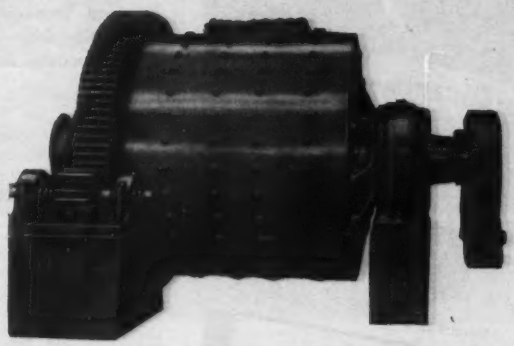
▶ Little May Mining Co. is sinking on a seam of lead-silver-gold ore at its Milford-Lilly property in the Star District, Beaver County, reports John H. Matson, president and manager.

▶ At Fish Springs, Juab County, the Silver Shield Mining & Milling Co. is driving a tunnel to intersect the Early Harvest shaft.

▶ New ore is being developed at the Marsac mine, Park City, on the 1,300 level, reports James B. Allen, the company's president.

▶ Howell Mining Co. has agreed to finance development of four claims—a part of the Emma mine, at Alta, and property of the Cabin and the Zella mining companies. J. J. Beeson, Salt Lake City consulting geologist, will direct the work.

The BIGGEST NEWS in the Mining Industry



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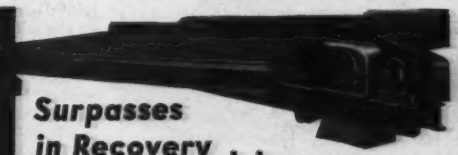

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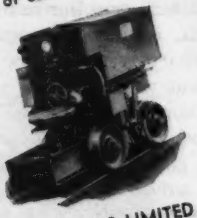

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IDAHO

Little Pittsburgh Mine To Have Flotation Plant

Zinc-lead property reopened by Lessee Mining Company—Fire destroys buildings at Ima tungsten mine, at Patterson

▶The Little Pittsburgh mine, on Pine Creek, west of Kellogg, has been reopened by the Lessee Mining Co., a new organization headed by Dennis P. Woods, a Spokane, Wash., mining engineer. The property, a lead-zinc producer, has been idle since 1930. The orebody has been opened for 400 ft. on the lower tunnel level. The ratio is about three zinc to one lead. A modern flotation mill will be put in operation, with the zinc concentrate going to Anaconda, Mont., and the lead to the Bunker Hill smelter, at Kellogg. Vale W. Rudisile, of Kellogg, is vice president and Lauren D. Hudson, of Kellogg, secretary-treasurer.

▶Fire swept through several buildings at the Ima mine, tungsten producer at Patterson, causing damage of thousands of dollars, according to W. P. Barton, manager. The power house, blacksmith shop, and shower house were burned. Machinery losses included two diesel engines, two compressors, and other equipment. Two thousand gallons of diesel oil were also consumed.

▶Airplanes of the Johnson Flying Service are delivering mail to snow-bound prospectors of south central Idaho. Flying out of Cascade, the planes make twice-a-week trips to isolated sections and where landings are impossible drop mail by parachute.

▶Capacity of the milling plant of the Yellow Pine gold mine has been increased from 150 tons daily to 400 tons. About 70 men are employed in the open-pit operation. The mine is owned by the United Mercury Mines Co., of Boise, and is being operated by the Bradley Mining Co. with H. D. Bailey as general manager.

▶Coeur d'Alene Mines Corp., silver belt, has completed a contract with the Bunker Hill smelter, at Kellogg, for treatment of its concentrates. The ore has been going to Tacoma since the start of production two years ago. Shaft operations will be started soon from the 1,400-ft. level with the 2,000-ft. mark as the ultimate objective.

▶Rob Roy Mining Co. will resume development work at its property in the Sunset Peak district north of Wallace. Paul Liber, of Wallace, has been elected president; Mike Tirpak, vice president; Ray M. Darius, secretary-treasurer; Gottlieb Garber and George Bennyhoff, directors. All are residents of Wallace.

▶The Troy Sillimanite Co., Robert Olson manager, Herman Krier secretary-treasurer, has been formed for the purpose of exploiting a large deposit of sillimanite. The company's office is Troy, Idaho. The deposit is situated in Latah County, Idaho, about 8 miles east of Troy.

▶North Bunker Hill Mining Co., in the Wardner district, was the scene of an important ore disclosure on Feb. 20, when the drift from the 500-ft. level of the main shaft disclosed upwards of 3 ft. of lead-silver ore of good milling grade. Assays showed 29.40 oz. silver, 8 percent lead, and 4 percent zinc. Crosscuts will now be driven to determine width of the ore showing. N. T. Hardy, of Kellogg, is secretary-manager.

▶Idaho mines paid approximately $9,000,000 in wages and salaries during 1940, according to Arthur Campbell, State Mine Inspector. Materials and supplies used by the mines cost about $3,000,000, ore transportation and smelting, about $6,000,000, and taxes, about $2,000,000. About 7,000 people were directly employed in the mining industry, and more than 50,000 persons depend on it for a living.

▶Jack Waite mine, under operation by the American Smelting & Refining Co. in the Murray district, is reported to have found high-grade galena ore in a winze 65 ft. below the 2,000 level on the Montana side of the property.

▶Sunshine Mining Co. is experimenting with a chemical process to remove antimony from the company's ore concentrates before shipment to the smelter, which charges a penalty for treatment of that ore. The new process removes the antimony in metallic form, making a commercial product. A pilot plant treating two tons a day is reported to be working satisfactorily and will probably result in installation of a full-capacity plant.

WASHINGTON

Magnesite Company Operating at Capacity

A 300-ton flotation plant installed by Northwest Magnesite—Turk copper mine, in Stevens County, being reopened

▶Northwest Magnesite Co., at Chewelah, has attained to the utmost of its present capacity and now has 600 men employed. Because of the heavy demand for its magnesite products, the company is carrying out a fourfold program of expansion. A processing plant for producing magnesite dust has been completed. Additional drying sheds are being built, which will enable the company to increase its output of Thermax, a building board used in Army and Navy hangars. The company has had its electric substation rebuilt to insure an uninterrupted flow of power. A fourth phase of expansion will be a 300-ton flotation mill to concentrate magnesium ores. Dean A. W. Fahrenwald of the University of Idaho School of Mines has been consultant and supervising engineer for mill construction and has worked out processes to be used.

▶Sultan Basin Co. has acquired the old Turk mine, in the southwestern part of Stevens County, and has made a contract with Deertrail Monitor Mines Co. for the reduction of its ore in the latter company's mill. The ore from the Turk will be trucked to the mill. It is expected the ore handled will have a

copper content of 5 to 6 percent, with some gold. The mill is primarily designed to handle molybdenum ore, found in the Deertrail property. J. Richard Brown, of Spokane, is in charge of the Deertrail operations.

▶ Western Molybdenum Corp., two miles northeast of Chewelah, has installed an electrically driven air compressor and other new equipment and is expected to start operations soon. The ore is molybdenum and copper. A shaft opens the mine on three levels.

▶ American Graphite & Metals Corp. is treating 50 tons of ore a day at its plant four miles from Omak. The ore contains molybdenum, gold, and graphite. Neil Parker is mill superintendent, and Joseph R. Laycock is manager.

MONTANA

Chrome-Bearing Deposit To Be Exploited

Low-grade ore to be treated in plants located in Stillwater County—Mill to treat manganese from Emma mine expected to start operations in May

▶ A group of Montana interests headed by certain responsible citizens of that State have leased certain chromite claims in the Ben Bow region. They are seeking a loan from R.F.C. for exploitation of these deposits and the building of a metallurgical plant. Anaconda Copper Mining Co. was approached by government officials to serve as manager of the operations, and the company has accepted this responsibility.

▶ Anaconda is constructing a mill at Anaconda to treat manganese ore from the Emma mine, in Butte. The manganese has been contracted for by the Metals Reserve Co. The flotation plant is designed to treat 1,000 tons a day. A sulphide concentrate will be sent to the zinc concentrator, and the rhodochrosite concentrate will go to nodulizing kilns, where a product assaying about 60 percent manganese will be made. The mill is scheduled to go into operation around the first of May. Alterations of the plant at the Emma mine, which will produce the manganese ore, are now in progress.

▶ Martin Mining Co. is treating 125 tons daily in its plant at Silver, 15 miles northwest of Helena. The mill feed consists of tailings from the old Drumlummon mill, at Marysville, which were swept downstream by a flood many years ago and deposited on a meadow. The accumulation of organic matter in the tailings since their deposition makes roasting necessary in the present operation. The tailings are excavated with a pull-shovel and trucked to a stockpile, from which they are fed to a roaster fired with natural gas. The calcine is then ground and treated by countercurrent cyanidation. Carl Martin, 29 Shiland St., Helena, is general manager.

▶ Twelve men are working on leases at Quartz Hill, an old silver camp 40 miles southwest of Butte. The ore contains silver and occurs in fissure and blanket veins in limestone. C. H. Burgess, Green Lane, Butte, is superintendent of the Quartz Hill Mining Co.

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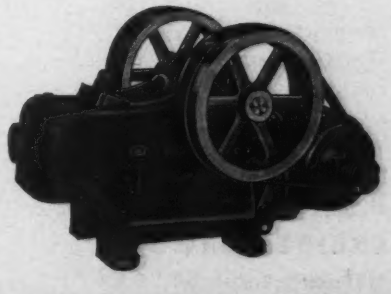

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Wide World Photo

Herbert Moulton, outgoing president, congratulates John Robert Suman as he takes office as president of the Institute for 1941. Mr. Suman is vice president of the Humble Oil & Refining Company, Houston, Texas

A.I.M.E. Meeting Attracts Largest Attendance on Record

About 2,750 mining and metallurgical engineers appraise their latest technology and discuss problems involving supplies of raw materials for national defense — George C. Bateman, Controller of Metals in Canada, delivers address at all-institute luncheon.

INTENSE ACTIVITY in the metal-mining industry throughout the Western Hemisphere was reflected in the largest attendance on record at the annual meeting of the American Institute of Mining and Metallurgical Engineers, in New York City, on Feb. 17-20. Engineers from Canada, Mexico, Central and South America, England, Africa, and many parts of the United States gathered to exchange technical information and seek enlightenment on problems and rapid occurring events in the industry and its strategic position in the national defense program.

A new feature, that was well received by the members and the ladies, was the all-institute luncheon at the Commodore Hotel, at which George C. Bateman, Controller of Metals of the Canadian Ministry of Munitions and Supply, addressed an audience the size of which exceeded the expectations of institute officials. Mr. Bateman, who is also president of the Canadian Institute of Mining and Metallurgy, impressed his listeners with the energy, vigor, and sacrifice the Canadian mining industry is exerting in its defense problem. His subject was "Canadian Control of Metals in the War for Democracy." He said:

"The metals control is only one phase of Canada's war efforts, but its acceptance by industry and by people is typical of what is found in many phases of our activities. We have adopted a planned economy. Profit is no longer the dominating factor in our industrial life. Our people are not only prepared to sacrifice profits but also to sacrifice many things which we have come to regard as necessities. We are prepared to sacrifice, temporarily, at least, our personal liberties, to reduce our expenditures, and pay taxes on a scale we have never before known; we are prepared to do these things willingly in the knowledge that we are engaged in a desperate struggle, that victory can be won only by a supreme effort and by mobilization of all of our human and material resources and that without victory all that we have and all that we hope for in the future is worth nothing."

Mr. Bateman said the outstanding position of the Canadian mining industry has been the result of the coordinated effort of capital, labor, and management.

Among the technical meetings held on Feb. 17 there was a joint session of Committees on Reduction and Refining of Lead, Zinc, and Copper, at which a paper by E. C. Truesdale and R. K. Waring, of the New Jersey Zinc Co., was presented, entitled "Relative Rates of Reactions Involved in the Reduction of

Zinc Ores." Recent developments in lead-smelting practice were presented by O. P. Chisholm, of the American Smelting & Refining Co. Other subjects discussed on that day were "Influence of Geophysics Upon Geology Curricula"; and "Industrial Minerals and Milling Methods." Papers on milling covered spotlight technique in the industry on grinding, tailings re-treatment, and flotation of arsenical quicksilver ore. A. L. Blomfield, managing director of Lake Shore Mines, discussed fine grinding investigations at Lake Shore Mines. L. M. Barker, concentrator superintendent, and E. G. Lewis, metallurgist, of the Phelps Dodge Corporation, presented a paper entitled "Developments in Ball Mill Grinding Practice at New Cornelia." R. G. Thompson and E. Clarence Peterson, of the International Smelting & Refining Co., Utah, had a paper on "Reclamation and Treatment of the Ophir Hill Tailing Deposit." Interest in quicksilver ores was found in the paper by Maurice Rey and H. Brevers entitled "Differential Flotation of Arsenical Quicksilver Ore."

On Tuesday Victor Rakowsky introduced the discussion of the sink-and-float process, and Grover J. Holt described the subject of "Ferrosilicon Art, as Practised in Two Butler Bros. Plants on the Iron Ranges." Advances made in this method (sink-and-float) as applied to zinc were described in a paper by Elmer Isern and Robert Ammon entitled "Advances Made in the Eagle-Picher and American Zinc Mascot Units Employing Galena as the Suspensoid."

Mining papers discussed on Tuesday, with F. A. Wardlaw Jr. as chairman, were "Homestake Mining Company's Carrier-current Shaft Signaling System," by John F. Wiggert, chief electrical engineer, Homestake Mining Co.; "Modified Mining Methods in the United Verde Mine of the Phelps Dodge Corporation," by J. B. Pullen, Phelps Dodge Corporation; "Blasting Practices at the New Cornelia Open Pit Copper Mine of the Phelps Dodge Corporation," by Harry H. Angst and Reuel A. Cochrane. A paper by E. R. Borcherdt, of the Anaconda Copper Mining Co., was presented and discussed by T. T. Read, of Columbia University. The geology, mining, and milling of the manganese ore in the Embreeville district, in east Tennessee; a paper by Stanley O. Reichert, assistant geologist, Tennessee Division of Geology, was presented by W. F. Pond, Tennessee State Geologist. During the afternoon, a mining session was held with Gerald Sherman as chairman, J. B. Caulfield, general superintendent Hudson Bay Mining & Smelting Co., and E. Bachman, consulting electrical engineer, had a paper entitled, "The South Main Shaft—Its Construction, Development, and Electrical Installation." W. H. Goodrich, assistant superintendent of mines, Chino Mines, Nevada Consolidated Copper Corporation, presented a paper, "Electrification and Change in Haulage Methods at Chino Mines."

Extension of the scope of placer dredging was discussed in a paper by Charles M. Romanowitz and H. A. Sawin, of the Yuba Manufacturing Co. Advantages and development of a three-wing rock drill used in the Tri-State district were discussed by S. S. Clarke, superintendent of Eagle-Picher Mining & Smelting Co.

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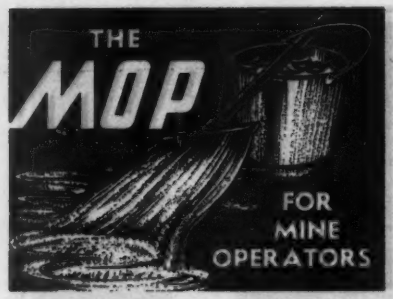

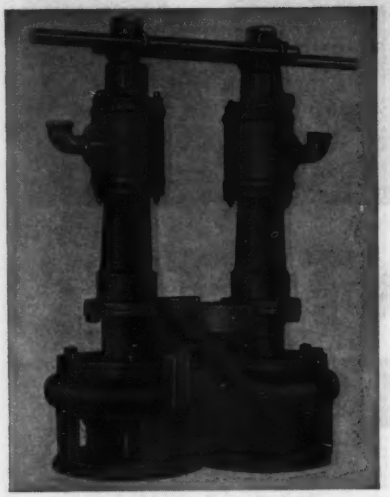

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A symposium of block caving provoked discussion on the efficiency of block-caving operations and procedure in removing caved ore. The recent use of shaking conveyors in copper mines employing the block-cave system of mining was described. Discussion on the subject of block caving was made by Philip Bucky, of Columbia University; Mark A. Smith, of Ruth, Nev., H. A. Leidich, of Philadelphia; Sherman R. Burdick, of New York, N. Y.; McHenry Mosier, supervising engineer, metal mining research section, U. S. Bureau of Mines. Comments by R. W. Hughes, mine superintendent, Miami Copper Co., and R. T. Gallagher, Colorado School of Mines, were read at this meeting.

A symposium on rock bursts provoked interest and discussion upon theories, and the general consensus of opinion was that, actually, little is known about this phenomenon, but some progress has been in predicting rock bursts. Discussion was offered by A. F. Robertson, Wright-Hargreaves Mine, Kirkland Lake; A. B. Yates and P. G. Shenon, International Nickel Co., Copper Cliff, Ontario; and R. D. Parker, Chairman Ontario Mining Association Rock Burst Committee. Paul H. Bird, Bureau Water Supply, New York City, described the occurrencies of rock burst in the Delaware Aqueduct.

At the annual banquet and reception, held at the Hotel Commodore on Feb. 19, H. G. Moulton, retiring president, gave the Anthony F. Lucas award to Mrs. Henry G. Doll. The medal was won by Mrs. Doll's father, the late Conrad Schlumberger, and her uncle, Marcel Schlumberger, who is in France, for their development of the art of electrical coring or electrical logging.

The William Lawrence Saunders medal for distinguished achievement in mining was given to Herman C. Bellinger, vice-president of the Chile Exploration Co., the Charles F. Rand Memorial Gold Medal, to Robert C. Stanley, president, International Nickel Company of Canada, Ltd.; and the Robert Woolston Hunt Awards for 1941 went to A. B. Greninger and A. R. Troiano, respectively assistant professor of metallurgy, Harvard, and assistant professor of metallurgy, Notre Dame, and to George E. Steudel, division superintendent of the Carnegie-Illinois Steel Corporation, Chicago. The J. E. Johnson, Jr., cash prize award was given to Carl F. Hoffman, superintendent of blast furnaces of the Sparrows Point plant of the Bethlehem Steel Co. John Robert Suman, vice president of the Humble Oil & Refining Co., was inducted as president of the A.I.M.E. for 1941 at the banquet and Dr. Paul D. Merica, vice president of the International Nickel Co., took office as vice president of the Institute.

Tin Smelter to Be Built in Texas City, Texas, by Dutch Interests

Plant will have capacity to produce 18,000 ton of tin annually

AFTER MANY MONTHS of discussion, R.F.C officials finally perfected a contract with Dutch interests to build a smelter in Texas City, Tex., to process the Bolivian tin ore for which purchase contract was announced last fall.

The decision favoring Dutch interests announced by Jessie Jones, Federal Loan Administrator, on Feb. 26, rested on two considerations, it is reported. In the first place, this group has had more actual experience in smelting refractory Bolivian ores than any other available person or corporation. Second, it was hoped that establishment of such an enterprise under Dutch sponsorship might result in a permanent operation in this country, perhaps later using ores from the Far East. Whether the latter hope can be realized remains uncertain, however.

The contract is between Metals Reserve Co. and an N. V. Billiton subsidiary called Tin Processing Corporation, 10 Rockefeller Plaza, New York, using $3,500,000 of government money for construction at Texas City, Tex. (near Galveston). The deciding factors in selecting this site were cheap gas for fuel, available hydrochloric acid, and at low cost, from a nearby refinery; good terminal, port, and warehouse facilities, a large movement of foreign ships into the Galveston-Houston Marine district, making it possible to move less than cargo lots of this concentrate coming from South America; and availability of barge movement of finished tin market. The site was donated by the Texas City Terminal Company. The Grace Line announced on Feb. 27 inauguration of new freight service between western ports of South America and carrying tin ore and concentrates to Texas City.

The contract provides for designing and building of the new plant for a fee of 4 per cent of the cost of the project. Operation under the contract will be for a fee of 1 per cent of the value of the tin produced. The plant will be entirely owned by the United States Government and operated for its account, with an option to take over or change the management at stated periods. Fifty thousand tons of tin concentrate will be handled to produce about 18,000 tons of tin annually if the Bolivian deliveries are as expected. An improved heat and acid process will be used in recovering the metal. J. van den Brock is president of the Tin Processing Corporation, and Dutch engineers of Billiton now in this country who will aid in designing and constructing the smelter are W. Vierling, J. F. W. van der Meulen, J. P. Peyrot, and W. Nittle. B. C. M. van der Hoop, vice president of the Tin Processing Corporation died in an airplane crash, near Atlanta, Ga., on Feb. 28th, enroute to visit the plant site.

TRI-STATE

Drilling Finds Promising Zinc Area to Be Developed

Kansas Explorations, Inc., a subsidiary of St. Joseph Lead, plans shaft sinking and mill construction near Oronogo

▶What promises to be one of the outstanding developments in the Missouri section of the Tri-State mining field this year is the work which has been inaugurated by the Kansas Explorations, Inc., on the Snapp land, two and one-half miles northwest of Oronogo. The company, which is a subsidiary of the St. Joseph Lead Co., owns the 40-acre tract and has a large acreage under lease in the immediate vicinity. Reports are current that additional drilling has disclosed good orebodies of both zinc and lead at various depths. A large drill hole was put down to the 370-ft. level, in which a 14-in. casing was set. A 12-in. Peerless turbine pump has been installed in the hole to dewater the area. With the start of pumping operations, the company also started the sinking of a shaft near by and the building of a concentration plant. The latter will have a capacity of from 40 to 50 tons of ore an hour, according to Ross Blake, of Joplin, district representative of the company, who is in charge of operations. George Scheurich, of Joplin, is the millwright and John Miller will supervise the shaft-sinking operations. A compressor plant is being built to house two large Ingersoll-Rand compressors—one of 800 and the other of 1,200 cu.ft. capacity. An office building and other structures also are being erected at the new mine and mill site. A power line was extended a distance of four miles to the new development by the Empire District Electric Co. to furnish power for all operating units. In addition to the old Isherwood and Robinson properties, formerly operated in the district by the company, the company now is operating the Ritz mines and mill near Cardin, in Oklahoma, and the Jarrett mill and mines north of Picher, in Kansas.

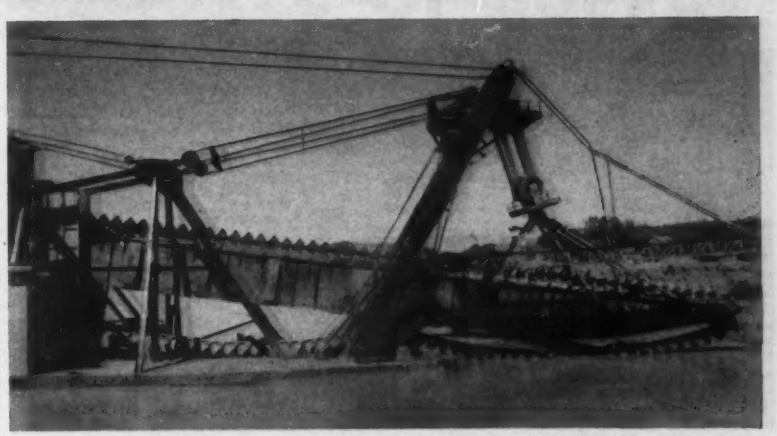
▶A new tailing plant is being completed by the Sciota Milling Co. on the old Missouri Zinc Field Co.'s land, southeast of Webb City. The plant will have a capacity of 50 tons of tailings an hour. Sam A. Smith, of Oakland, is supervising the construction work and will be in charge of operations.

▶Sale of the Captain Milling Co. to the Western Mining & Milling Co. has been announced by H. W. Harrison, of Miami, president of the former company. The transaction involved the transfer of stock held by stockholders of the Captain company to the Western company, with the purchase price of the stock undisclosed.

▶Lawyers Lead & Zinc Co. is sinking a new 230-ft. shaft northeast of the company's mill on the Thomas Buffalo lease, a mile southeast of Picher. George O. Pearson, of Joplin, is secretary-treasurer of the company.

▶Stateline Mining Co. is opening a good

DIGGING 124 FT. BELOW WATER LEVEL



Digging Ladder Yuba Consolidated Gold Fields No. 20.

Placer dredges for deep digging are operating successfully in California today largely due to the use of Patented Perry Bucket Idlers. Yubas No. 17 and No. 20, near Hammonton, California, using these idlers, are digging 112 ft. and 124 ft. below water level respectively—and are digging against banks 50 ft. or more high where necessary.

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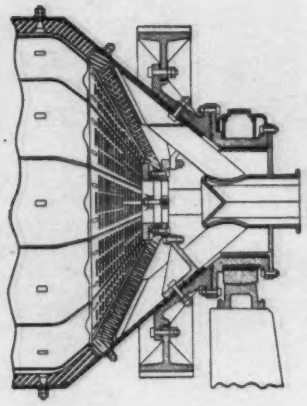

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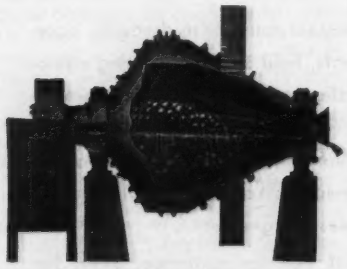

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▶TRI-STATE

zinc deposit in virgin ground at the north shaft on the Lea land, about three-quarters of a mile west of Central City and just north of U. S. Highway 66, according to Harry C. Gray, of Joplin, one of the partners.

▶ Dines Mining Co. has started mining operations on the old Northern lease, a mile and one-half north of Treece, according to H. G. Weidman, of Baxter Springs, superintendent.

▶ Stotts City Mining Co. is sinking a new 180-ft. shaft on the Davies land, which is situated south of the old Loklyn Lead & Zinc Co. property just west of Stotts City. Earl Childress, of Baxter Springs, is president of the company and Kenneth Childress is in charge of operations.

▶ W. E. Cluck, of Baxter Springs, is reopening a shaft on the Clark land, a 40-acre tract which adjoins on the south the old Century Zinc Co.'s Discard lease, south of Baxter Springs, in Oklahoma. The shaft, which was sunk by the Century company in 1928, will be opened on the 200-ft. level.

IRON COUNTRY

Sherwood Shaft Nears First Level

New mine of Inland Steel Co. to be developed rapidly—Work at the new deep shaft of Cleveland-Cliffs Iron Co. advances

▶ Good progress is being made at the Sherwood shaft of the Inland Steel Co. on the Menominee range, Michigan. Sinking has progressed to around 400 ft. and operations are under way for starting the first level. Sinking will be continued to 1,280 ft. R. D. Satterly is superintendent, with office at Ishpeming, Mich. The company has also started reopening of the Ravenna-Prickett property near Crystall Fall, Mich., where a temporary headframe is nearing completion. Howard McLeod is in charge of rehabilitation at the property.

▶ Another large shaft-sinking project, that of the Cleveland-Cliffs Iron Co. near Ishpeming, is advancing at a good rate. Ground was broken on Jan. 6 by manager S. R. Elliott for the shaft to be sunk eventually to 4,000 ft.

Titanium Bearing Magnetite Deposit May Be Acquired In New York State

TITANIUM Pigment Corp., subsidiary of National Lead Co., is negotiating to acquire the old MacIntyre Iron Mine, Tahawus, N. Y. The orebody is a titanium-bearing magnetite. The property has been shut down for about 30 years. Most of the titanium ore used in this country in the production of titanium oxide comes from India. High freight rates, resulting from the war, now virtually prohibit the movement of ilmenite from India. If the mine should be purchased by National Lead, rehabilitation of the property is not expected until some time this summer.

Under normal conditions, Indian ilmenite is quoted at from $10 to $12 a ton, Atlantic ports. At present, the freight rate from India amounts to more than $20 a ton.

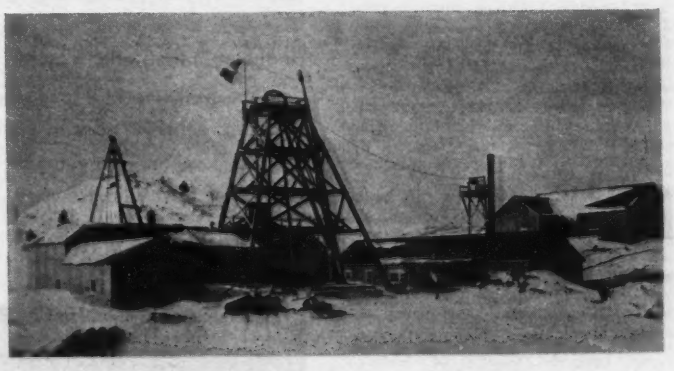
CANADA

Exploration Continues at Britannia Mine

Shaft sinking expected to be projected below the 4,100-ft. level to develop deeper ore formations

BRITISH COLUMBIA

▶ Existence of a new orebody has been proved on the horizon of the 4,100 level of the Britannia mine, in the Howe Sound district, according to the 1940 annual report of the Howe Sound Co., operators of the Britannia property.



On this site a steel headframe 182 ft. high will be erected over a shaft now being sunk to 2,900 ft. and later to 4,000 ft. Ground was broken for this new shaft on Jan. 6, by Cleveland-Cliffs Iron Co., near Ishpeming, Mich. Iron ore will eventually be hoisted in 12-ton skips. Headframe and buildings above are temporary as shaft sinking gets under way

The mine was operated continuously throughout the year, but the scale of operations was necessarily decreased commencing Nov. 1, due to a shortage of skilled labor and the necessity of diverting personnel to carry on essential exploratory work, between the 2,700 and 4,100 levels, although diamond drill tests were run to greater depths. A pilot shaft is now being sunk below the 4,100 adit, and when sufficient structural information has been obtained to determine the proper location, a shaft of large capacity will be provided. The mineralized zone on the horizon of the 4,100 level was outlined above the tunnel and partly developed by drilling to a depth of over 300 ft. below it. This work, as previously indicated, has proved the existence of a commercial orebody of importance. Further exploration of the area will be continued in 1941.

▶Development work on the Homeward Mines, Ltd., property in the Nomash Valley of the Zeballos district, continues to produce satisfactory results. The 50-ton flotation-amalgam plant will be in readiness for operation in March. Power for the generator is supplied by pelton wheels with a direct hook-up to the compressor. A standby diesel plant will be installed later. A 1,600-ft. double-track tram will be ready for service at the same time as the mill.

▶Ore reserves of approximately 140,000 tons averaging better than 0.4 oz. gold per ton continue to be maintained at Sheep Creek Gold Mines, Ltd., in the Nelson District. Present development work has been largely centered on the promising "92" vein, and possibilities of the Nugget section are being ascertained by drifting. Lack of a stable market for zinc concentrate has resulted in abandonment of the company's option on the Tyee Consolidated property.

▶Materially increased millheads during the next few months will result from stoping operations on the 3,500 vein on the 1,400 level of the Gold Belt mine, in the Nelson district. Assays across a 3-ft. width over an aggregate length of 300 ft. average 0.8 oz. gold per ton.

▶Net income of $96,430.01 after providing for taxes, development, and exploration costs is reported by Hedley Mascot Gold Mines, Ltd., Nelson district, for the final quarter of 1940. Heads averaged 0.454 oz. of gold per ton, and 16,329 dry tons of ore were milled during the period. Earnings per share before depreciation and depletion amounted to 4.259c. Development since the date of last report has been mainly confined to driving the 4,510 raise to completion, according to Dr. V. Dolmage, consulting engineer.

▶The Monarch mine, at Field, was operated to capacity by Base Metals Mining Corp. throughout the final quarter of 1941 and the company announces the immediate resumption of production at the Kicking Horse mine. More favorable returns for zinc concentrate are resulting from a new sales agreement which became effective Oct. 25 last. John D. Galloway has resumed his former position as manager of the Monarch operation after having spent some time in charge of Jerome mines in northern Ontario.

▶During 1940 the Tadanac plant of

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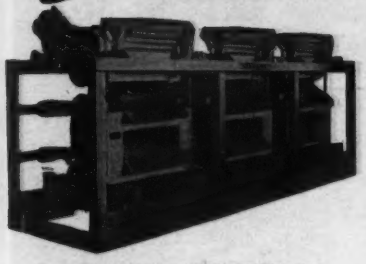

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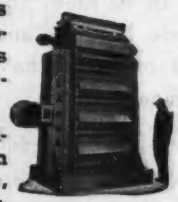

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▶CANADA

Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, B. C., received 39,092 tons of ore and 5,596 tons of concentrates from customs shippers, as against 41,487 tons of ore and 5,537 tons of concentrates during the preceding year. Reports on receipts from company-owned mines, which constitute by far the largest proportion of ore treated at Trail, are not disclosed, by reason of war-time restrictions.

▶Commencing Feb. 1, a war-time cost of living bonus was instituted by the majority of British Columbia mines. This varies from 20 to 21c. per shift to all men on day wages. Some equitable arrangement for salaried employees is under consideration. Employees of Consolidated Mining & Smelting Co., and of coal mines operating under agreements with the United Mine Workers of America, were already in receipt of similar war-time bonuses.

ONTARIO

▶Hollinger Consolidated Gold Mines, Canada's foremost gold operator, after completing 30 years of operation, reports both ore reserves and bullion output at highest levels in the mine's long history. Since 1911 Hollinger has produced gold amounting to $303,476,000, of which more than a third has been paid out in dividends. Noah Timmins, who stayed with the mine through early struggles, continued as president until 1934, when he was succeeded by Jules R. Timmins. A capable staff under John Knox as general manager has developed the mine to the stage where successful production is assured for many years. With workings carried to depths of less than 6,000 ft., 40 percent of the ore drawn last year was mined above the 800-ft. level. The 30th annual report shows an increase in average recovery of 36c., to $9.46 a ton; operating cost was reduced 18c. a ton, to $4.92, and the mill rate advanced 195 tons daily to 4,905 tons. Taxes jumped 219 percent to $2,302,201 on gross production valued at $16,844,035. Ore reserves have a valuation of $97,585,389. Work has been completed on the No. 26 shaft and in the early spring the company expects to complete the No. 27 lower level shaft at the Schumacher end of the mine, extended to the 4,550 level.

▶Falconbridge Nickel Mines in January regained capacity output of both mine and smelter, after operations had been curtailed to about two-thirds of normal capacity since last April, when Germany cut off the Norwegian refinery. Profits in 1940 dropped drastically to $277,903, compared with $2,009,404 the year before. Refined metal stocks in Norway were written off, valued at $233,279. Other net assets in Norway are carried on the balance sheet at $1,194,800. The president, J. Gordon Hardy, has advised shareholders that net income, since the dividend of 7½c. was paid from first-quarter earnings in 1940, has been conserved for protection of the property. Net working capital was increased by $800,000. Drifting and crosscutting in ore totaled 8,573 ft., chiefly to prepare for stoping and to open the 1,750-ft. level to connect the No. 1 and No. 5 shafts. Manager E. Craig reports that the crusher station at 2,540 ft. has been operating since last July. Ventilation equipment is being installed in the mine, connecting with a raise driven to surface from the end of a 700-ft. crosscut on the 325 level.

MANITOBA

▶The Main or West orebody of Sherritt Gordon Mines has been traced for an additional length of 1,000 ft. by drill exploration carried on during the past year, and the East orebody has been tested for a 4,000-ft. length. The two sections are separated by 3,500 ft. of barren ground and represent a total ore length of about 11,000 ft. Ore is transported by aërial tramway from the East workings to the concentrator. The top of the shallow, flat-lying orebody reaches a maximum depth of 700 ft. as far as explored to the west. In vertical dimension the ore varies from 200 to 1,000 ft., taking the deepest workings to 1,500 ft. Halstead Lindsley, president, reports sales of copper in excess of present production, making net income for last year $3,602,210. Copper output is assumed to be similar to the 1939 figure of 31,000,000 lb. Working costs, including charges for smelting and refining, were 7.226c. per pound, of which 4.128c. per pound covered mining and concentrating, or $2.03 per ton mined. Last year the West mine produced 88 percent of the ore, down to the sixth level. The East mine went into production in May, 1940, and accounted for 12 percent of the total tonnage mined. Eldon L. Brown is general manager.

▶All-time records were made in tonnage, bullion output, and operating profits by San Antonio Gold Mines. President John D. Perrin advised shareholders that more than three times as much new ore was developed as was mined in 1940, with ore reserves increased to 756,718 tons. This calculation includes only a small percentage from the deeper workings below the tenth level, where new ground was recently opened. The general manager, D. J. Kennedy, describes the 40 vein as the most important discovery made during the year. It has a length of 451 ft. on the 15th level and averages 13 ft. in width, giving promise of large tonnage after stopes have been opened. The mill, averaging 334 tons daily for the past year, is to be stepped up next August to 550 tons. Net profits of $481,135 were derived from 1940 production valued at $1,414,700. Provision for taxes was $165,000, up from $77,000 in 1939.

NORTHWEST TERRITORIES

▶In January, Slave Lake Gold Mines started producing gold bullion and tungsten-copper concentrates with equipment rated at 50 tons a day. On the third level a 64-ft. raise that had been put up by former operators and revealed only low gold values has been completed through to the second level. The last 40 ft. is in continuous ore averaging one

ounce. On the second level a combined ore length of 197 ft. has been prepared for two stopes. Ore is being drawn from two stopes on the third level. Gross value of 15,000 tons of positive ore is $40 a ton, with mining, milling, and shipping costs estimated at $18.

▶Negus Mines, in the Yellowknife district, treated 1,897 tons in December, with estimated value of $75,152. Within the next two months official action is expected on declaration of the initial dividend and enlarging the mill beyond its present 60 tons daily.

▶Bear Exploration and Radium, controlling eleven properties in the Yellowknife area, plans to ship a 50-ton mill to Giant Yellowknife Mines, using the first water transport this spring to Slave Lake. A 125-ft. incline shaft and extensive diamond drilling have indicated excellent possibilities for the vein, which has a continuous length of 100 ft. in the drift and is shown by drill holes to extend another 550 ft. Last summer gross returns of $37,000 were realized from 131 tons of hand-sorted ore from development work, on a shipment to Trail, B. C.

▶Preparations are well advanced at Thompson-Lundmark Gold Mines for commencing production next summer. Consolidated Smelters have agreed to advance up to $350,000 and have shipped the Cordova mill from Ontario, its rated capacity being 100 to 150 tons. Hydroelectric power has been contracted for and a right-of-way cleared for the transmission line. The Thompson is about 30 miles from the Negus and Con mines at Yellowknife. The Fraser and Kim veins, 2,500 ft. apart, have been undergoing development for the past two years. The Fraser shaft is to be deepened from the 600 level to 750 ft. and the Kim vein has been opened to the 300-ft. horizon. A substantial tonnage of ore grading better than one ounce has been indicated.

MEXICO

Strike at Rosita Zinc Smelter Settled

President Camacho intervenes and contributes a constructive labor plan of adjustment to the mining industry

▶Mexican mining conditions with regard to labor brightened considerably at the end of winter with demonstration of what the new government can do in getting national industry in a smooth working order. The high spot of this was the settlement, with the intervention of President Manuel Avila Camacho, of the strike that lasted four months and four days against American Smelting's units, Mexican Zinc and the Cia. Carbonifera de Sabinas, S. A., the latter a coal mining enterprise, Nueva Rosita, Coahuila. This intervention induced the workers to pare down from 14,000,000 pesos ($2,850,000) to 1,000,000 pesos the biennial costs to the companies of their demands in the form of higher wages and other concessions. The companies agreed to pay half wages during the strike and 50,000 pesos ($10,150) as costs of the conflict. Both sides agreed

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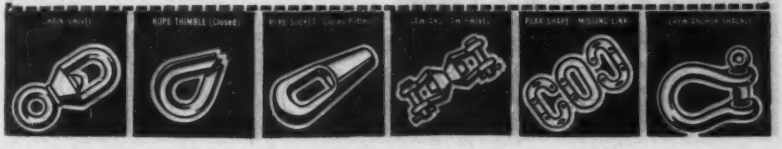

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TAPES RULES PRECISION TOOLS

▶MEXICO

to let President Avila Camacho arbitrate some minor points in the dispute, such as increasing the pay of 23 confidential employees and fixing senority rights in the matter of filling vacancies. This was the new President's first direct intervention in a mining work dispute and is seen as fixing a precedent in these cases. The action is hailed as most encouraging by the mining industry.

▶ Mining circles are indignant about the strike threat made by the national miners' union against two small companies that are among the most important in northwestern Mexico, Cia. Minera de Santo Domingo, S. A., Nacozari, Sonora, H. H. Horton, general manager, and The Golden Girl Mining, Nayarit. The union is to call the strike if the companies do not make the new collective work contract their employees demand. The companies assert that their economic condition is such that they cannot meet the higher wages and other concessions the pacts entail. This is the first strike move against small mining companies since the Avila Camacho government started.

▶ The new labor ministry, recently elevated from the status of a department, is showing what it can do toward maintaining peace in the mining industry. It headed off two strikes, one aimed at The Fresnillo Company, Fresnillo, Zacatecas, and the other that had started against Minas de Pinos Altos, S. A., Juan D. Morales, Rayon, Chihuahua, president and general manager, a small company at Pinos Altos, Ocampo municipality, Chihuahua. The ministry induced the Fresnillo folk to accept arbitration of their grievances. It put the Pinos Altos men right back to work shortly after they had struck by declaring the strike illegal because it was unjustified.

▶ Unnamed American interests are reported to be negotiating with the Aguascalientes government for the establishment of a large smelter in or about Aguascalientes City. The government is said to be favorably disposed toward granting this franchise, as the plant will employ several hundred men and increase ore-treatment facilities in central Mexico.

▶ Agustin Guzman V, secretary general of the national miners' union and other officials of that organization, have protested to President Camacho against accusations made to him by a delegation of 22 members of the San Luis Potosi section of the union that the organization's leaders are "artificially creating disturbances in the mining industry to exploit the companies by making the workers the instruments of their ambitions."

▶ Conversations for a revision of the labor contract of American Smelting's unit at Parral, Chihuahua, have been transferred to Mexico City, at the request of the labor ministry, because they were not producing results on the ground. The ministry is supervising these conversations and expects good results from them.

▶ Action of the labor ministry and the

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Write for Bulletin 375.

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PASSAIC NEW JERSEY U S A

Durango government ended a row between miners who are cooperatively operating properties at Ojuela, Durango, recently leased from Peñoles, and many prospectors who virtually invaded the lands. The miners were induced to permit the prospectors to work part of the properties. The miners are controlling this work and buying ore from the free lancers at prices that are fixed by the ministry and the Durango government.

AUSTRALIA

Mt. Morgan Increasing Mill and Smelter Capacity

Output of copper to be stepped up 50 percent—Copper deposits in Victoria being prospected

Queensland

▶Alterations at Mt. Morgan, involving extension of the smelter and conversion of the former oxide ore treatment plant to a sulphide mill, will enable expansion of copper output to about 50 percent above last year's figure. This means that probably 6,000 tons will be produced in future yearly. Total cost of the extensions has been £A70,000. The new oxide ore treatment section of the mill, which has been under construction for some time, is now in operation.

Victoria

▶Boyd Mining Syndicate of Victoria Co,. Ltd., is engaged in testing a copper deposit at Mount View, Cudgewa, Northeastern Victoria. Shallow depths only have as yet been reached, but the ore in one lens at a depth of 18 ft. is 8 ft. wide, carrying 1 percent copper and 0.8 dwt. gold, and in another 6 percent copper and 1 dwt. gold. Work is being continued with the object of developing the property sufficiently to form an operating company at a later date.

▶Victorian gold mining in 1940 had a banner year, with production and dividends the best for over 20 years. Although the yield has not been officially announced it was above that of 1939, which was the best since 1922, the return from Bendigo alone being nearly 18,000 oz. greater. There was great prospecting activity at Bendigo, principally caused by the rich returns from the operating companies on the Deborah line, and at the close of the year 36 companies were working on the field, as compared with 20 a year before.

▶A local syndicate has commenced work in the Lal Lal district, near Ballarat, to test the possibilities of the quartz reefs which occur in the area.

Western Australia

▶Gold yield for 1940 was 1,191,481 oz., some 23,000 oz. less than last year. The reduction, however, was only apparent, as the mines are now cleaning up every four weeks instead of every month, and

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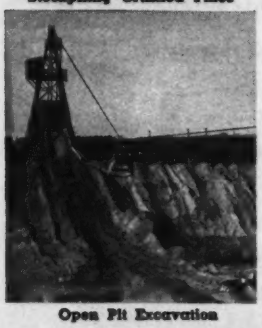

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▶AUSTRALIA

the December clean-up occurred about the middle of the month. Actually, the yield for the complete year was about 4,000 oz. in excess of that of 1939. The principal producing field was East Coolgardie, which includes Kalgoorlie.

▶ Directors of Coolgardie Brilliant, N. L., which is operating a lease at Wiluna, report that ore reserves have been increased to two years' mill supply, with prospects of improvement. The company is treating about 1,000 tons monthly in a ten-head battery, and is erecting further leaching vats to increase the throughput of sands to 700 tons monthly.

▶ Swan Bitter Gold Mining Co., N. L., has purchased the Morning Star lease at Mt. Magnet, and proposes to issue further shares to provide funds for the unwatering and equipment of the mine.

New South Wales

▶ It is reported that options are being sought on the Lucknow gold field by a Victorian company, which plans to test the field to a depth of 1,500 ft. in a campaign to take twelve months and cost £A20,000. If satisfactory results were obtained, a company would be formed to amalgamate all interests in the field.

Fiji Islands

▶ The annual reports of both the Emperor and Loloma companies afford evidence of the permanency and worth of the Tavua gold field. At the Emperor, for the year to June 30 a net profit of £A232,761 was made, resulting from the treatment of 165,214 tons of ore, which yielded 49,171 oz. fine gold, average grade being 6.90 dwt. per ton. Ore reserves at Sept. 4 are estimated at 820,000 tons positive and 60,000 tons probable ore, average grade being 7.6 dwt. per ton. Capacity of the mill has been somewhat reduced on account of treatment of the harder sulphide ore, but additions now being made to the fine-grinding section should rectify this. Net profit of Loloma for the year ended July 31 rose by over £95,000 to £A289,382, 32,342 tons of ore being milled for a return of 48,006 oz. fine gold. Head value was 30.45 dwt. and extraction 95.7 percent. Ore reserves at Sept. 4 are set down as 149,450 tons of an average value of 23.2 dwt. per ton, the tonnage rising by 8,000 tons, and grade dropping 1.6 dwt., as compared with last year's figure. The main features of the year's development work were the sinking of the main (Theodore) shaft to No. 5 level, driving north and south at Nos. 4 and 5 levels, and extending the drives at No. 3 level, all of which work, it is reported, has opened up good tonnages of ore. Another potentially important development is in the western orebody, where good values have been obtained. This is to be further investigated by diamond drilling and underground development work.

EQUIPMENT NEWS

Portable Ultra-Violet Light For Detecting Minerals

A PORTABLE LAMP UNIT known as the Mineralight for use to excite fluorescence in a wide range of minerals is announced by Ultra Violet Products, Inc., 3205 Santa Monica Blvd., Los Angeles, Calif. Several different types

of lamps are available for field, sorting table, and laboratory use. Each unit has special plug-in connections for either 110-volt or 6-volt transformer and battery. Type 420 is reported by the manufacturer best for prospecting and mining use, and is said to be capable of detecting scheelite and other fluorescent minerals at a distance of 10 to 15 ft. under normally dark conditions. The lamp employs a pure fused quartz tube, which generates the short ultra-violet rays.

New Steel Track Tie

THE ANCHOR TIE, a new H-beam tie for use in mine and industrial tracks, of simple design, having only four loose parts, has recently been developed by Bethlehem Steel Co., Bethlehem, Pa. (U. S. Patent No. 2,224,731). The gage of the track is definitely fixed at the mine or place of manufacture by two double-shouldered ⅜-in. tie plates, 5½ in.

wide, arc-welded to the 6-in. H-beam, which is 8 ft. long and weighs 15½ lb. per foot. Four 3x3x½-in. angles are arc-welded directly beneath the tie plates between the two flanges of the beam, to act as stiffeners and retainers for the spring clamp. The combination of beam, tie plate, and angles forms a stiff pedestal construction, at the point of maximum load. The spring clamps have enough "give" to create a resiliency to the whole track structure. There are no holes or notches punched in the tie section to weaken it at any point. The rails are fastened to the ties by means of clamps of heat-treated spring steel, four clamps for each tie. The clamps are driven into place with an ordinary spike maul or a sledge hammer. To remove the clamp from the tie a blow is struck with the spike maul against the hump, driving it back over the corner of the angle. It is said to be easier to install than wood ties, and requires less maintenance than either of the other types.

The Anchor tie is said to have been tested for the last three years on a piece of industrial track where excep-

tionally heavy service is encountered. Four hundred ties were used in the test track. In examining the track it was reported that the ties withstood lateral movement better than any other type of steel or wood tie.

Rubber Springs for Mine Cars

DEVELOPMENT of rubber springs for mine cars is announced by the United States Rubber Co., Rockefeller Center, New York, N. Y. These springs, according to the manufacturer, offer a number

The rubber springs indicated by arrows are the compression type. They go into effect when the car is loaded and take the total weight of car and load

of advantages over conventional steel springs which have been used for many years. Among advantages claimed are, better spring action; quieter ride; greater dependability; increased economy, greater safety.

The rubber springs are being introduced on the new, streamlined, all-steel car built by Irwin Foundry & Mine Car Co., of Irwin, Pa., for a mining company in the East. Three hundred of these modern cars thus equipped were scheduled to be placed in service this spring. Two types of rubber springs are used in this installation. One is a shear and the other a compression type spring. The shear type spring carries the load while the car is empty. There are four of these springs on each car. They carry a load of 5,000 lb. Each spring measures ¾x3 7/16x3¾ in. The compression type spring carries the total weight of car and load. There are

Rubber is indicated by the black material within the circles. These springs are of the shear type, that carry the car while empty

also four of these springs on each car. They carry a total load of 19,000 lb. Each spring measures 4x13x1¾ in.

The advantage of increased economy and greater safety are said to be found in a factor of design which tends to prevent derailment. The danger of derailment is reduced because the rubber springs exert a load on each wheel of 1,400 inch-pounds.

New Handy Ohm's Law Calculator

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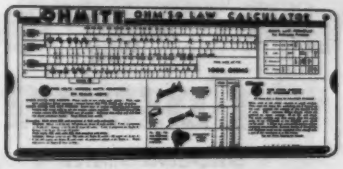
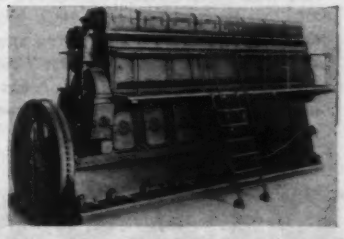


quickly, with one setting of the slide. All values are direct-reading. The calculator has scales on both sides, so as to cover the range of currents, resistances, wattages, and voltages commonly used in the industrial and electronic fields. It covers the current and wattage range for motors, generators, lamps, electrical apparatus, and other uses up to 100 amps., or 1,000 watts; also low-current high-resistance radio, sound, and electronic applications.



Chicago Pneumatic Tool Co., 8 East 44th St., New York, N. Y., announces its new Type 16 diesel engine of the four-cycle, direct-injection type, especially designed for continuous duty. This new unit is available in five sizes to meet the requirements of various industrial fields

For Steady, LOW-COST Drilling!

"DIXON"

WASHER TYPE

AIR HAMMER COUPLINGS

"DIXON" Air Hammer Couplings meet every condition of service on hand hammer and rock drill operations with maximum economy and reliability. Simple construction, yet exceptionally strong and durable to withstand incessant vibration and rough usage. Cadmium plated—rustproof. Coupling complete consists of male or female spud, stem, wing nut, clamp and washer.

Compact Type, Style WLD-7, ½" and ¾W.
Heavy Type, Style WHD-9, ¾" and 1"

"GJ-DIXON"

GROUND JOINT

AIR HAMMER COUPLING

Same as above, except *washerless*. Instead of a washer, a copper insert in spud (male or female, as specified) fits accurately against rounded head of steel stem, forming soft-to-hard metal seal that remains leakproof, regardless of wear or the presence of sand, grit or other abrasive particles. No washers to wear out or be mislaid. Cadmium plated—rustproof.

Compact Type, Style XLD-41, ½" and ¾".
Heavy Type, Style XHD-52, ¾" and 1"

On your next order, be sure to specify "DIXON" or "GJ-DIXON" Air Hammer Couplings. Your rubber manufacturer or jobber stocks them for immediate delivery

DIXON
VALVE & COUPLING CO.

MAIN OFFICE and FACTORY: PHILADELPHIA, PA.

Branches

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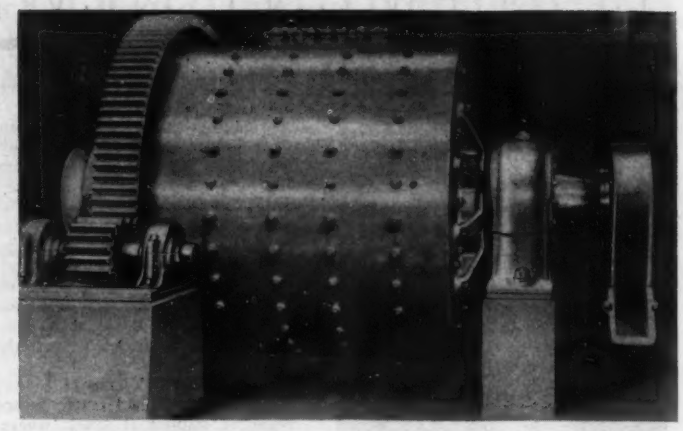
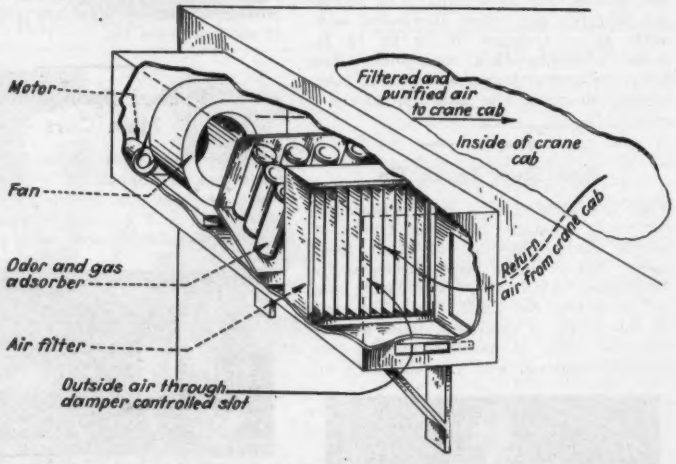
New Ball Mills



STRAUB Manufacturing Co., 507 Chestnut St., Oakland, Calif., recently announced a new line of ball mills known as the "Champion" Rib-cone ball mills. Six styles are offered, some of which can be converted to longer length if increased capacity is required. The shells of these new mills are of heavy steel plate rolled to a true circle and double welded to heavy steel heads strongly reinforced. Trunion bearings are large, babbitted, self-aligning type mounted in saddles that rest on a steel sole plate which extends under the pinion shaft bearings. The large-diameter pinion shaft is furnished with sealed self-aligning SKF ball or roller bearing. Liners are of manganese steel having the manufacturer's patented spiral lifter ribs. The grate-discharge type of mill is furnished with an alloy-steel discharge grid and properly curved pulp lifters. It may be driven by flat belt or V-belt. Size of these mills ranges from 4x3 ft. to 5x8 ft.

Odor Adsorbers Protect Crane Cab Operators From Gas



TO PROTECT crane cab operators from sulphur dioxide and other injurious gases, the American Smelting & Refining Co. has installed Dorex odor adsorbers on crane cabs at its Garfield, Utah, copper smelter. By this means, the company not only safeguards the health of employees but greatly increases their efficiency. Prior to installation of the unit, air in crane cabs showed a high sulphur dioxide content which has been completely eliminated.

Dorex odor adsorbers are manufactured by the W. B. Connor Engineering Corp., 114 East 32nd St., New York, N. Y. The device operates on the principle of the standard gas mask—gas and odor elimination by carbon adsorption. A fan, driven by a small motor, pulls air through perforated metal canisters filled with specially treated, Dorex activated coconut-shell carbon. The carbon extracts and holds gases and odors, allowing purified air to pass. In the crane cab application, an odor adsorber unit is attached to the exterior of the cab, and the cab itself is closed so that all air must pass through the unit. Both the outside air, which is admitted through a damper-controlled slot, and the return air from the cab, pass through the carbon filter, thus maintaining a constant gas-free atmosphere within the cab.

Dorex units are designed to meet almost any gas or odor problem, whether of intake, exhaust, or recirculation. The crane-cab application, pioneered by the American Smelting & Refining Co., is said to be one of the latest and most striking uses of the carbon adsorption principle.

New Diesel Lubricant

A NEW TYPE of lubricant for heavy-duty, high-speed diesel and gasoline engines has been announced by Standard Oil Co. of New Jersey. Known as Esolube HD, it is designed to overcome piston varnishing, ring sticking, and similar lubrication troubles. The oil is highly detergent, washing metal parts free from sludge deposits which are kept in suspension. It has a high viscosity index, which is a measure of stability, or ability to resist changes in "body" with changes in temperature.

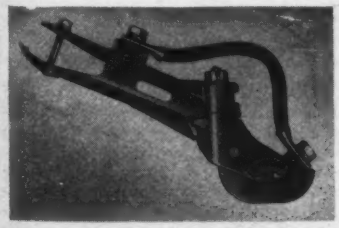
Electrical Device Measures Oxygen in Any Gas

A MEASURING INSTRUMENT that is said to determine automatically the amount of oxygen in any gas was recently announced by the Cambridge Instrument Co., Inc., 3732 Grand Central Terminal, New York, N. Y. Called the Cambridge oxygen recorder, it operates from the electric supply line and provides continuous indication and graphic record of the percentage of oxygen in any gas. No chemicals are said to be used in the instrument. The standard scale range is 0 to 5 percent oxygen on a 10-in. scale, but the instrument can be sealed in ranges of 0 to 2 percent oxygen full scale and 0 to 100 percent oxygen full scale.

Determinations by this oxygen recorder are said not to be affected by variation in the constituents of the sample gas, because a differential measurement is performed. Various analyzing cells may be combined so that the instrument will provide a complete gas analysis on one chart.

L Shoe for Heavy-Duty Current Collection

OHIO BRASS CO., Mansfield, Ohio, announces development of a new shoe or glider for collecting current from standard trolley-wire overhead systems, designated as the O-B Type L Shoe. Recommended for use on locomotives which require more current-collecting capacity



than is provided by trolley wheels or light shoes, the Type L Shoe is cast in one piece. A feature of the design is the method of mounting the shoe in the harp. The pivotal center of the shoe is located in the center line of the wearing surface. With this location as a pivot point there is no tendency for the shoe to tile because of the friction between the wire and the shoe. Consequently, the shoe is always held with the full length of contact against the wire, whether the locomotive is standing still or going in either direction.

Mines large and small report savings up to 25% on powder. For Calcot Tamping is scientifically designed to meet underground conditions. Calcot seals the powder charge tightly and thus assures a more complete detonation of powder. Furthermore Calcot means safety. Fireproof and non-inflammable, it cannot support combustion, cannot smoulder in the muck-pile, or set fire to timbering. Ready to use, uniform, light to carry, easy to insert, Calcot is the modern way to produce greater fragmentation and reduce blasting costs. Yet Calcot costs you less than 1c per hole!

NATIONAL AUTOMOTIVE FIBRES, INC.—Oakland Division
Dept. E1, Oakland, California

CALCOT TAMPING
Tampcot
CHEAPER THAN DIRT
SEND FOR FREE SAMPLE AND NEW BOOKLET

BRAUN ASSAY FURNACES

Built for the Job they Have to Do

Left to right—Braun Muffle Furnace, Combination Furnace and Bullion Melting Furnace

Braun Assay Furnaces are built to specifications demanded by practical assayers everywhere. These sturdy little furnaces have been as simply designed as possible, with the convenience of the assayer and the speed and efficiency of the work foremost in mind. Charges can be easily handled and temperatures readily controlled. Every construction detail helps to produce rapid, perfect assays.

The Braun Furnace line include a complete selection of Muffle, Combination and Bullion Melting furnaces of various capacities. They are available either singly or as complete furnace and burner outfits, with burners for gasoline, oil, artificial or natural gas and cylinder gas.

Install these compact, efficient furnaces in your laboratory for better assays.

For detailed information write Dept. E-3 for our new Furnace Bulletin C-141

BRAUN CORPORATION
2260 EAST 15TH ST. LOS ANGELES, CALIF. U.S.A.
San Francisco, California
BRAUN-KNECHT-HEIMANN CO.
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Seattle, Washington
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MineVent
FLEXIBLE

BLOWER PIPE

because

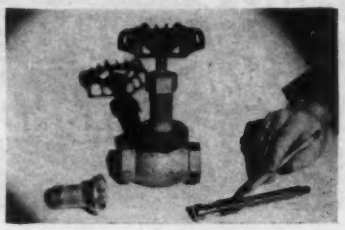
No matter what your conditions may be, MINE VENT will furnish inexpensive, dependable, ventilation for you. . . Rapidly installed by use of the newly developed demountable split coupling.

This new coupling has everything the mine or tunnel foreman has wanted . . . ease of installation . . . nothing to wear out, bend or break . . . positive action insuring a neat, quick and leak proof connection.

AMERICAN
BRATTICE CLOTH CORP.

Alloy Valve Stems

HANCOCK Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a new, longer-wearing alloy, called Hancodur, for valve stems and bonnets. This self-lubricating alloy



was developed expressly for use in Hancock Superfinished "500 Brinell" bronze valves. It is claimed by the makers that repeated breakdown tests indicate that these new Hancodur valve stems and bonnets outwear other stems and bonnets six times. It is said that these stems have a tensile strength of 90,000 lb. per inch plus a high self-lubricating characteristic that resists galling and wear.

Winter Lining For Safety Hats

MINE SAFETY Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa., announces a new type of winter lining for its Skullgards which is so designed and attached to the Skullgard that every part of the head, neck, and ears is covered to provide complete protection against cold and snow. The M.S.A. zipper type winter lining consists of two parts: (1) a skullcap, laced into the hat shell integral with the sweatband, and (2) earlugs, that zip into this skullcap. This lining can be readily assembled into a skullgard in the field and will not affect the original sweatband size.

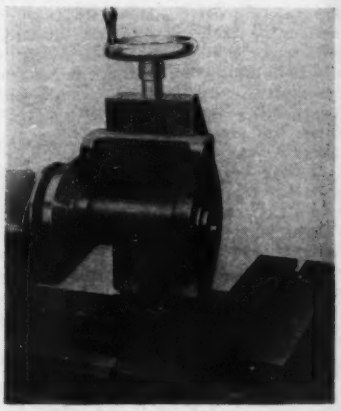
Earth-moving Machine

FILLING THE NEED for a high-speed, rubber-tired earth-moving machine, with the efficiency, construction, and proved design of the Standard C Tournapull, but with a more powerful engine and a larger capacity Carryall, R. G. LeTourneau, Inc., has introduced two new Super C Tournapulls designed to meet the needs of long-haul earth-moving jobs. Powered by either a 130 or 150 hp. six-cylinder diesel engine, the Super C

utilizes this extra power to increase the production per hour by pulling a Model LP Carryall with a struck capacity of 12.1 and a heaped of 15 cu.yd. Inasmuch as the LP is said to hold four more heaped yards of material than the Model LS used with the smaller C Tournapull, production can be increased as much as 35 percent.

Convertible Shovel

A NEW, lightweight ¾-cu.yd. convertible shovel-dragline-crane, Model 75, is announced by Link-Belt Speeder Corp., 301 W. Pershing Road, Chicago, as a companion to its popular LS-85 heavy-duty ¾-cu.yd. machine. All-welded steel construction has replaced castings in the new "75." The power plant is a heavy-duty gasoline or diesel engine with smooth-running roller chain drive. Alloy steel, machine-cut spur gears, drive the reverse and drum shafts. External band clutches are said to enable the operator to "feel" the load at all times. This sensitivity, plus external band brakes operated by automotive type pedals, is said to result in perfect control of the load and the greatest accuracy in placement. Controls operated from within the cab permit steering in both directions. A positive traction lock, controlled from the cab and engaging in three positions, prevents movement of the crawlers while working, eliminating any necessity for chocks or blocking.



A milling head that can be easily and quickly attached to standard lathes, turning the lathe into a milling machine, is announced by the Globe Products Manufacturing Co., Los Angeles, Calif. These units are made standard for use on ten different types of lathes

Wedge Gate Valves

A NEW AND COMPLETE LINE of standard iron body wedge gate valves for 125 lb. steam, 200 lb. cold working pressure has just been brought out by Crane Co., Chicago, Ill. This new line includes both the brass trimmed and the all-iron patterns with O.S.&Y., or nonrising stem, in sizes 2 to 12 in., inclusive. Among the important features of these new valves is the redistribution of body and bonnet materials, which eliminates all excess weight and yet complies with all standard requirements. Handwheels are of strong malleable iron; deep stuffing boxes permit a generous amount of packing; the body-bonnet joints employ a flat gasket closely bolted together, so that gasket compression is evenly distributed, and seat rings are of the shoulder type to retain tight contact with the body in spite of the difference in expansion characteristics.

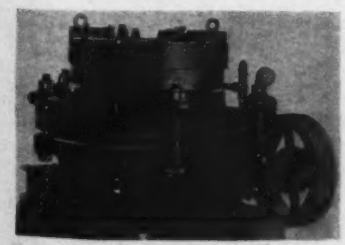
Detachable Bit

TIMKEN Roller Bearing Co., Canton, Ohio, has placed a new M Series detachable rock bit on the market. This bit is designed for drilling unusually hard rock formations with heavy drilling equipment. Although it is a heavy-duty bit, it is intermediate between the H series, which is normally used with light- and medium-weight rock drills, and the heavy-duty D Bit Series, normally used on wagon and tripod drills. As yet, the new M Series is available only in a limited range of sizes.

This rubber-tired industrial tractor, powered by a 90-hp. diesel engine and capable of hauling more than 13 tons of earth at 18 miles an hour, has been announced by Caterpillar Tractor Co., of Peoria, Ill. "Caterpillar" has also designed and built an 11-cu. yd. heaped-measure, bottom-dump, pneumatic-tired wagon, shown above, to go with the new tractor. Hydraulic scrapers, especially designed for the machine, are manufactured by the La Plant-Choate Mfg. Co., Inc. of Cedar Rapids, Iowa; and cable controlled scrapers, by R. G. LeTourneau, Inc., of Peoria

Synthetic Rubber Packings

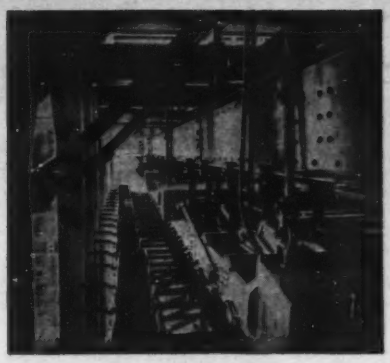
TWO NEW TYPES of packing, one made of Ameripol, its own synthetic rubber developed after 14 years of research and revealed last summer, and the other of Koroseal, the synthetic elastic material also created in its laboratories, are announced by B. F. Goodrich Co., Akron, Ohio. Both are sheet packing. The Ameripol product is a dark sheet packing superior to natural rubber and other synthetic packings in its resistance to the action of oils. It is said to age well, and provides excellent resistance to heat and cold as well as water absorption. The Koroseal packing is specially compounded to resist the action of oils and solvents, and also resists the action of some corrosives.



Due to the success of its 18-in. Telesmith Intercone Crusher during the past several years, the Smith Engineering Works, 532 E. Capital Drive, Milwaukee, Wis., announces the addition to its line of a 28-in. intercone crusher offered to the producer whose demands call for large capacity

JEFFREY-TRAYLOR ELECTRIC VIBRATION

...A PRINCIPLE THAT SPELLS *Lower Cost Material Handling!*



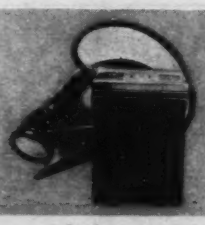
AS AN EXAMPLE . . .

IT INCREASES THE EFFICIENCY OF FEEDING REVERBERATORY FURNACES

● Jeffrey-Traylor (patented) electric vibrating conveyors efficiently overcome difficulties encountered in feeding reverberatory furnaces the conventional way. Void of any mechanical wearing parts whatsoever, this J-T feeding set-up is especially suited for such hot, severe service as reverberatory furnace feeding requires. Due to electrical control, spot-feeding of ores and sinter at any point can be regulated as desired. This cost-reducing electric vibrating conveyor is just one of many J-T applications of this sound principle . . . let us send you details on how it applies to screens and feeders.

JEFFREY-TRAYLOR DIVISION
The JEFFREY MANUFACTURING Company
974-99 NORTH FOURTH STREET . . . COLUMBUS, OHIO

WHEAT
THE ENGINEERED
CAP LAMP



Note 2 BULBS

Engineered for
UNIFORMLY BRIGHT BEAM
No "Blackouts"

There are three reasons for real "light insurance" when you use the Wheat. One is the peculiar ability of the Wheat Battery to maintain a substantially *higher voltage throughout the discharge* at the designated rate. The other is its ability to *resist* high rates of current on *short circuit*. The third reason is the Krypton Bulb, so mounted as to eliminate shadows ("black spots")—*plus the spare* standby bulb that gives you *at least* 24 hours emergency service should the main bulb be put out of business.

In addition to all this, there's a Wheat REFLECTOR to give you the proper beam to meet all mining conditions—whether you're working in big space or a confined area, whether you want a floodlight or a beam "spot". In short you *get more light* with a lamp designed throughout for LESS WEIGHT and BETTER BALANCE . . . not to mention the great Wheat feature of self-service in charging in the lamp house (nothing to disconnect or open, any miner can do it by a twist of the wrist).

Write for detailed fully descriptive printed matter today.

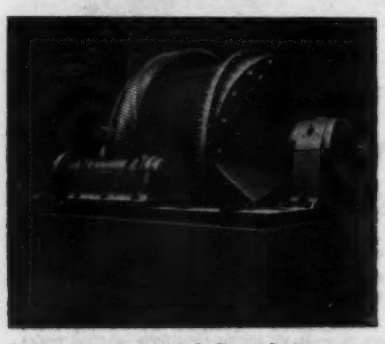
WHEAT CAP LAMP

KOEHLER MFG. CO.
Marlboro . . . Mass.

That dust Jack is working in day after day ... is it harmless? *Before* he slows up from lung congestion or something worse, give him a Willson Bantam Respirator. He'll be able to do a better day's work ... day after day, without a layoff. The Bantam weighs but 3¼ oz...is comfortable to wear for hours because it fits the contour of the face. By merely changing filters, the Bantam becomes U. S. Bureau of Mines approved protection against lead ... which means that you need stock but *one* respirator for all jobs. Ask for folder BR 40. E. D. Bullard Co., 275 Eighth Street, San Francisco, California. B-3

Everything BULLARD in Safety

MAKE THE MOST OF OUR RESOURCES NOW



Savings in power, ball and liner consumption are part of the per-ton economy distinguishing Williamson Mill performance — a present conservation need.

Williamson Mills are recognized the world over for their low cost of operation — high grinding efficiency and sturdy reliable construction.

"It's the shape of the drum that does it"

Let us help you solve your grinding problem

WILLIAMSON COMPANY

582 Market St. San Francisco, Calif.

New Vibrating Screen

CRUSHING and Cement Division, Allis-Chalmers Mfg. Co., Milwaukee, Wis., has developed a new vibrating screen called the "Ripl-Flo," which is said to involve a new principle of operation. Having an eccentric shaft working with the unbalanced force of the counterweighted flywheels, the new mechanism vibrates the entire screen body in rapid, circular, gyratory motion. Its smooth operating characteristics, high capacity, and compact design are said to make it especially suitable for screening sand, gravel, stone, ore, and other granular materials. In brief, the screen consists of two high-tensile steel side plates spaced apart by welded-steel deck supports, with the operating mechanism inclosed in a tubular housing between the decks. The shaft is eccentric between bearings and provides much of the force which causes the screen body to gyrate. Fine adjustments for balance are made in the flywheels externally. The new screen is of the inclined type. The equipment may be supported by cables attached to an overhead structure or to existing overhead building member. Structural floor mounted bases can be provided where this type of mounting seems preferable.

This screen will be built in single- and double-deck types in sizes up to and including 6x14 ft. The single-deck screen is so designed as to permit easy change-over to a double deck screen, in the field, should the occasion for the change arise.

BULLETINS

Single-Stage Air Compressors. J. C. Buckbee Co., 2227 East 37th St., Los Angeles, Calif. Bulletin 120 describes and illustrates features of the Rotovane single-stage air and gas compressors and dry vacuum pumps. Pp. 4.

Cable Calculator. General Cable Corp., 420 Lexington Ave., New York, N. Y. The company offers a handy building wire calculator giving pertinent information on the various types under the new National Electric Code.

Crushers. Traylor Engineering & Mfg. Co., Allentown, Pa. Bulletin 1005 describes and illustrates features of the manufacturer's types TY and BH medium-fine reduction crusher and the Traylor-Stearns multi-stage fine-reduction crushers. Pp. 4.

Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin B6140 describes and illustrates the manufacturer's new "Electrifugal" pumps for 1 to 10 hp. for heads up to 160 ft. Pp. 6.

Rivetless Lip Dredge Buckets. American Manganese Steel Division, 956 Ferry St., Oakland, Calif. Bulletin 1140 describes features of the AMSCO rivetless lip dredge buckets. Pp. 4.

Motor Driven Compressors. Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y. Bulletin 726 presents improvements in several details of construction of CP two-stage compressors in capacities of 350 to 10,000 cu.ft. per minute for pressure of 80 to 125 lb.

Ball Mills. Straub Mfg. Co., 507 Chestnut St., Oakland, Calif. Bulletins 42 and 43 describe and illustrate the manufacturer's new Champion Rib-cone ball mills. Pp. 4.

Contour Metal Shaping Machines. 1301 Washington Ave. South, Minneapolis, Minn. The company offers a comprehensive ring binder brochure illustrating and describing the various machines built for continuous sawing, filing, and polishing. Pp. 45.

Power Plugs and Sockets. Howard B. Jones, 2300 Wabansia Ave., Chicago, Ill. Bulletin 500 describes and illustrates the manufacture of new line of plugs and sockets designed for 5,000 v. and 25 amp. and are made as 2, 4, 6, 8, 10, and 12 contacts. Pp. 8.

Automatic Switchgear for Mining Service. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Descriptive data 31-330 describes the company's automatic switchgear for synchronous converter substations in mining service. Pp. 8.

Fire Protection. C-O-Two Fire Equipment Co., 10 Empire St., Newark, N. J. Booklet C-24 illustrates and describes uses of carbon dioxide for fire extinguishment; hose systems and rechanging equipment. Pp. 8.

Pumping. International Nickel Co., Inc., 67 Wall St., New York, N. Y. The company offers an illustrated booklet containing comprehensive information on pumps and pump parts. The subject matter is treated in a semi-technical nature. Pp. 16.

Rotary Blowers. Roots-Connersville Blower Corp., Connersville, Ind. Bulletin 21-B-35 describes and illustrates the manufacturer's Victor-Acme rotary positive blowers for handling small and medium volumes of air against pressure or under suction, ranging from 8 oz. to 7 lb. per sq. in. Pp. 8.

Wire Rope Slings. Macwhyte Co., Kenosha, Wis. Catalog No. S-6 is an attractive book describing and illustrating the manufacturer's line of wire-rope sling for various industrial requirements in hoisting materials. Tables of breaking strength and safe loads, and other general information, are given. Pp. 56.

Short Head Cone Crusher. Nordberg Mfg. Co., Milwaukee, Wis. Bulletin 90 describes and illustrates the manufacturer's new Symons short-head type cone crusher. Pp. 4.